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DIALOGUES ON INSTINCT;

WITH

ANALYTICAL VIEW OF THE RESEARCHES

ON

FOSSIL OSTEOLOGY.

BY

HENRY, LORD BROUGHAM, F.R.S.,
And Member of the National Institute of France.

30

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NOTICE FROM THE EDITOR OF THE WEEKLY VOLUME.

ORD BROUGHAM has kindly consented to the re-ublication, in this cheap and compact form, of his Dialogues on Instinct" and his "View of the esearches on Fossil Osteology," which formed a onsiderable part of his "Dissertations on subjects f Science connected with Natural Theology," in he two supplementary volumes of the edition of aley's "Natural Theology," in 5 vols., by Lord rougham and the late Sir Charles Bell. Lord rougham has translated the Latin quotations for is edition.

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GENERAL NOTE RESPECTING EVIDENCES OF DESIGN

Place—**Brougham**, in Westmoreland.
Time—Sept. 1837.
Persons—*A*. **Lord Spencer** (**Althorp**).
B. **Lord Brougham**.

OF INSTINCT.

BOOK, OR DIALOGUE I.

INSTINCT—INTRODUCTION; (FACTS).

WHEN the General Election of 1837 was near its close, and every day brought the accounts of those mighty boasts of our expected successes under the new reign, so idly made, being overthrown by the activity and resources of our adversaries and the listlessness of the people on our behalf, Lord A. came to me on his way to the North, where he was minded to diversify with field-sports his habitual life of farming. Those pursuits had never interfered with the duty he owed his country as long as he deemed that the sacrifice of all his domestic comforts could prove serviceable to his public principles; nor had they ever at any time prevented him from cultivating a sound philosophy, in the study of which much of his leisure is always consumed. When I passed a few days with him at Wiseton, the summer before, we had discussed together some of the more interesting topics which form the subject of these speculations, connected with Natural Theology, though of a substantive interest independent of the relation in which they stand to that sublime inquiry; and, while I remained at Harrington, we had corresponded constantly on the subject of Instinct, one of the mos curious in its minute details and of the most interesting in its bearings upon the philosophy of mind independent of its immediate connexion with theological speculations, but, it must at the same tim be admitted, one of the most difficult, and upo which the labours of philosophers have cast a ver imperfect light. It was natural then that we shoul renew these discussions when we afterwards met i Westmoreland. The weather being fine, we range somewhat among the lake scenery, and by th rivers and through the woods which variegate ou northern country. There was not much to temp us in the aspect of public affairs, which, if no gloomy for the country at large, was yet not ver flattering for the liberal party, among whom th single object seemed now to be the retention o office, and who might say with the Roman patric in the decline of liberty,—"Nostris enim vitii non casû aliquo, rempublicam verbo retinemu reapse vero jamprídem amisimus."* Nor, indee on these matters was there a perfect agreeme between us two; for while we augured as little vourably the one as the other of our prospects, ascribed to different causes the condition of aff which gave rise to these forebodings: he, tra it to the great natural weight and influence of Tories throughout the country, both in churc state; I, relying more on the energies of a proved and active people, provided the gover

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* "By our own misconduct, not by any calamity, we may still have the name of a free government, *have lost the reality.*"—Cic. Frag. de Rep. lib. v.

d so as to merit their support; but lament-
no pains had been taken by them to show
eriority of popular principles, or make the
feel itself better off under their rule than
uld have been under the adverse faction,
perceived sufficiently plain indications that
ssion of the Court favour in this new reign
ave the effect of lessening rather than pro-
any popular tendencies which might still
Altogether, therefore, the state of the com-
lth was a subject less suited to engage our
tion; and we naturally dwelt little upon
and unpleasing topics, as unsatisfactory,
ry, and fleeting—"ista quæ nec percunctari
ire sine molestiâ possumus."* But upon
atters of permanent interest and universal
nce, and which the follies or faults of men
ot despoil of their dignity or deprive of
lish, we loved to expatiate; and coming to
nd in the neighbouring river, found a con-
seat where the discussion might be carried
r the cool shade which the wood afforded
an autumnal sun: "Here," said I, "we
sume our Wiseton conversation."—"Ven-
insulam est. Hâc vero nihil est amœnius;
hoc quasi rostro finditur Fibrenus, et divisus
r in duas partes latera hæc alluit, rapi-
lilapsus cito in unum confluit, et tantum
titur quod satis sit modicæ palæstræ loci;
cto tanquam id habuerit operis ac muneris
nobis efficeret sedem ad disputandum, statim
at in Lirem."†—"Here," said I, "we may

ings which we can neither inquire about nor hear
exation."—Cic. Acad. Quæst. lib. ii.

e came to the island. But than this spot nothing resume our Wiseton conversation;" "si videtur considamus hic in umbrâ, atque ad eam partem sermonis ex quâ egressi sumus revertamur."*

A. Have you reconsidered my opinion, or rather the inclination of opinion, which I had last year, that it will be advisable, if not necessary, to begin with defining Instinct, in order that we may the more clearly understand what we are discussing?

B. I have indeed; and I remain of my own, as often happens through obstinacy and unwillingness to give up a preconceived notion; but here it is, I believe, from much reflection upon the subject, that I still regard the definition as rather the end of our inquiry than its commencement. Indeed, this may generally be observed of metaphysical, or rather psychological inquiries: they are not like those of the mathematician, who must begin by defining; but that is because his definition is, in fact, a statement of part of the hypothesis in each proposition. Thus, whoever enunciates any proposition respecting a property of the circle predicates that property of a figure whose radii are all equal; and it is as if he began by saying, "Let there be a curve line, such that all the straight lines drawn from its points to another point within

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can be more agreeable; for here the Fibrenus is split as by the prow of a vessel, and being divided into two equal branches, washes the sides; then, after rapidly separating, it quickly unites in one stream, embracing space enough of ground for a moderate-sized place of exercise: after which, as if it only had the work and office of providing us with a seat for our discussion, it straightway falls into the Liris."—Cic. de Leg. lib. ii.

* "If you please we may here sit down under this shade, and revert to that part of our conversation from which we *had departed*."—Cic. de Leg. lib. ii.

it are equal, then I say that the rectangles are equal, which, &c." The general definition only saves the trouble of repeating this assumption, as part of the hypothesis in each proposition. But the nature of instinct, or of any other thing of which we discourse in psychology, is not the hypothesis we start from; it is the goal or conclusion we are seeking to arrive at. Indeed, so it is in physical science also; we do not begin, but end, by defining the qualities of bodies, or their action on one another.

A. I grant this. But if there be more things than one which men call by the same name, for example, of Instinct, must we not begin by ascertaining what we mean by the word, in order to avoid confusion? And this seems to bring on the necessity at least of some definition.

B. I agree that there must in this case be a definition; but it is only a definition of terms, and does not imply our stating the nature of the thing defined: it only implies that we must understand what the thing is to which the given word applies, and, if two things go under the same name, that we should be agreed in the outset which of the two things we mean when we use the word; perhaps, that we invest some second name, or give some qualifying addition to the given one, to express one of the two things, and keep the different meanings distinct.

A. The best way will be that we should come to particulars—give an example or two: perhaps it may suffice to mention the different kinds of Instinct, if, which I take for granted you do not doubt, there be more things than one going under that name.

B. Certainly; and there can here be no difficulty at all in our way; and, to show you how little alarmed I am at defining, when it is clear that I am only called upon to define a word, and thereby make a distinct reference to a thing known or unknown in its own nature—not to pretend giving an account of that nature—I will at once begin by both inventing names and defining their meaning. There are some Instincts which may be called *physical*, and others *mental*, in the anima system; by physical I mean those actions or motions or states of body which are involuntary; as the action of the heart, and the peristaltic motion of the bowels, over which, generally speaking, we have no direct control by the operation of the will—for I put out of view such rare instances almost monstrous, as Darwin has recorded of a person who could suspend the pulsations of his heart at pleasure, and another, still more rare, of one who could, at will, move his bowels by accelerating the peristaltic action.* Even if all men could acquire such control over those motions they would still be involuntary; because they could still be carried on wholly without our will interfering, and without our minds necessarily having any knowledge whatever of them. So the secretions are all performed involuntarily, and may go on wholly without our knowledge; we can affec them as we can the involuntary motions of the heart and fluids, indirectly, because the passion and feelings of the mind have always an effect upon them; but still they exist and proceed, the part perform their functions, and those functions serv the ends of their appointment, wholly independen of our will, or of any effort whatever on our part. We can affect them also immediately through the influence of physical agents, voluntarily applied as stimulants or sedatives, or the operation of voluntary motion, as well as mediately by the power which the mind derives from its union with the body; but they can go on of themselves, and, in all cases of healthy condition, go on better without any the least interruption on our part than with it.

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* Zoonomia.

A. This is certain: my only doubt is whether these can be justly or correctly termed instinctive operations at all. When I speak of Instinct, I mean something very different; namely, those voluntary movements, or that voluntary action of the mental faculties which is contradistinguished from reason. However, there is no harm, but much convenience, in beginning by defining and classifying, so as to leave on one side the physical and involuntary instincts—those things which may properly enough be called incidents of animal life, because there seems great difficulty in drawing a line between such motions and actions and those which subsist in vegetables.

B. There does certainly appear to be this difficulty. I hardly see how any line can be drawn between the motions of the lowest species of animal, the mollusca for instance, and those found in plants. There is in both organized form, a system of vessels, growth by extension not by apposition, a circulation of fluids and secretion of solids from those fluids, or of one fluid from another. There is also production of seed, and from the seed continuation of the species. But it is not only convenient that we should define in order to leave on one side what we are not to discuss, that it may not confound our inquiry; the definition and classification may also carry us on, some little way, in our argument with respect to the other class of Instincts, Instinct properly so called, the Mental Instincts; at least, it seems to furnish us at the very outset with an analogy.

A. I have a dread, at least a suspicion, of all analogies, and never more than when on the slippery heights of an obscure subject; when we are as it were ***inter apices*** of a metaphysical argument, and feeling, perhaps groping, our way in the dark or among the clouds. I then regard analogy as a dangerous light, a treacherous *ignis fatuus.*

B. It is even so, if we follow it beyond where we can see quite clear and find a firm footing. But all light is good, and the best way is not to despair, still less put out any glimmering we have, but rather to increase it by adding others, or make it available by using apt instruments. However, we are getting too metaphorical: only it is my comfort that you began, and that I am led astray by one who (as you said in your inimitable letter to your Lancashire antagonist) is not one of "the eloquent people." But to return from where your poetical imagery led us—analogy may sometimes illustrate, and it may often lead to useful and strict inquiry, by suggesting matters for comparison and investigation.

A. Then what comparison do you make between the two kinds of Instinct? or rather, as the question is of analogy, how do you state a relation of the mental Instinct, which we shall call Instinct simply if you please, similar to or identical with some relation of physical Instinct?

B. As thus—the physical Instincts are independent of will, or mind altogether, though they never are found except where animal life and consequently mind exists; but yet mind may influence them. Just so the mental Instincts are independent of reason altogether, though they are found in union with it and reason may influence them. It is a question if they are ever found without reason; for that depends on our solution of the *vexata quæstio*, "Whether the lower animals have reason at all or no?" Therefore, I will not say that here the analogy is complete, and will not affirm that, as physical Instinct is never found without animal life, so mental Instinct is never found without reason; but we may safely say that in this other respect the analogy is perfect, namely, that where mental Instinct is found with reason it can act without reason, though reason may also interfere with it; and in this respect, at least, reason seems to bear the same relation to mental Instinct which animal life bears to physical Instinct. We may go further, and add, that as in plants, where the motions are without animal life, those motions are more perfect and more undisturbed, so if there be any animal wholly without reason, the operations of mental Instinct are the more regular and perfect; and, in any animal whatever, they are so in proportion as reason is dormant or inactive.

A. It may be as you say; but this will not carry us, as you seem to be aware, far on our road. However, it is well enough to remark it; for we thus gain perhaps a clearer and more steady view of the relation between Reason and Instinct, always supposing that there is any warrant for treating the two as different: because you are aware that some have considered them as identical: I mean not merely by denying that there is any specific difference, any difference in kind, between our faculties and those of brutes—though this denial is of course involved in their doctrine—but by going a step further, and holding that what we call our Reason, and are so proud of, is merely a bundle of Instincts, as some have termed it—a more acute and perfect degree of Instinct. Smellie, in his entertaining work on the Philosophy of Natural History, holds this opinion.—That is a book, by the way, much less esteemed than it deserves, even as a collection of facts and anecdotes; but I also think the honest printer (for such he was) had a good deal of the philosopher in him. I suppose, as the well-educated printers in the foreign university towns, and some of our own Oxford men, used to be critics and scholars, from the atmosphere of the place, so your Edinburgh printer, when well bred, is a metaphysician.

B. You are right as to Smellie at least, and I agree with you as to his book, though it is too long, and in parts loosely reasoned, as well as not over-accurate in his facts, according to what I have heard from naturalists. But he was a man of considerable merit; and lived a good deal in the literary and scientific circles of Edinburgh. I knew him, but slightly. He would have done much more had his habits been less convivial. But I rather fancy the somewhat pretending title of his book tended to make men disallow the merit which it unquestionably has.

A. But what do you hold of the dogma in question, and of which he is perhaps the most round asserter?

B. I entirely deny it; nor do I conceive that any part of the subject is more free from all doubt than this, unless indeed we come to the question of liberty and necessity, and resolve the whole into a mere dispute about terms.

A. Liberty and necessity! preserve us!—I am taken by surprise. Why I had no idea that we could ever have got among those heights and clouds already—"apart set on a hill retired," and reasoning on "free-will," like the gentry more acute than amiable, who held their metaphysical disputations there.

B. Don't be alarmed—but the subjects in one single point do certainly touch. What I mean is this: if you say that, when a man reasons, one idea suggests another, and that he must follow the train, and can no more avoid drawing his conclusion, when he compares two ideas, than a bird can avoid building its nest in a particular fashion, or a bee can help making hexagonal cells, then you seem doubtless to liken Reason with Instinct. But this is true only on the supposition that a man's mind is mechanical, and that his faculties are placed beyond his control. Now, suppose it to be admitted that I cannot avoid drawing a certain conclusion from premises in mathematical matters—as that the three angles of a figure are equal to two right angles, if that figure have those three angles only—I am under no such necessity in any question of moral or probable evidence; and on a question like that different minds will differ, or the same mind at different times. Again, I am under no necessity—even if I admit that I have no choice on moral evidence—I am under *no necessity* of exercising my volition in one given way, unless indeed you deny that I have ever any free-will at all. If so, and if you contend that, the same motives being presented to my volition in the same circumstances, I must needs choose the same course, you may also contend that, the same circumstances being presented to my judgment in the same frame of the feelings, I must needs draw the same conclusion; and this may seem to make out an identity of Reason with Instinct: but this is the dispute of liberty and necessity which every man's consciousness and hourly experience decides in favour of liberty, except in so far as it is a mere dispute about terms. But I really do think that, allowing the question to be disposed of either way, there is a specific difference between Reason and Instinct: for, even upon the principle of necessity, suppose the man and the bee to be equally under the entire control of the premises in reasoning, and the circumstances or motives in willing, whatever it is that each does, be it the necessary consequence of the circumstances or not, is different in the two cases. Suppose that if the bee reasoned she would be under the necessity of drawing the same conclusion, and that if she exercised an election, she could not avoid choosing one course, and that it is the same with the man—it still is not only not proved that the bee does reason or choose, while we know that the man does, but the contrary seems proved.

A. How so? Were I to maintain the contrary I should deny that we have any such proof. How do you prove the negative proposition, that the bee does not reason and will?

B. Observe, I do not say we have the proof of the negative as clearly as we have of the affirmative. But, beginning with laying aside those actions of animals which are either ambiguous or are referable properly to reason, and which, almost all philosophers allow, show a glimmering of reason; and confining ourselves to what are purely instinctive, as the bee forming a hexagon without knowing what it is, or why she forms it; my proof of this not being reason, but something else, and something not only differing from reason in degree but in kind, is from a comparison of the facts—an examination of the phenomena in each case—in a word, from induction. I perceive a certain thing done by this insect, without any instruction, which we could not do without much instruction. I see her working most accurately without any experience, in that which we could only be able to do by the expertness gathered from much experience. I see her doing certain things which are manifestly to produce an effect she can know nothing about, for example, making a cell and furnishing it with carpets and with liquid, fit to hold and to cherish safely a tender grub, she never having seen any grub, and knowing nothing of course about grubs, or that any grub is ever to come, or that any such use, perhaps any use at all, is ever to be made of the work she is about. Indeed, I see another insect, the solitary wasp, bring a given number of small grubs and deposit them in a hole which she has made, over her egg, just grubs enough to maintain the worm that egg will produce when hatched—and yet this wasp never saw an egg produce a worm—nor ever saw a worm—nay, is to be dead long before the worm can be in existence—and moreover she never has in any way tasted or used these grubs, or used the hole she made, except for the prospective benefit of the unknown worm she is never to see. In all these cases, then, the animal works positively without knowledge, and in the dark. She also works without designing anything, and yet she works to a certain defined and important purpose. Lastly, she works to a perfection in her way, and yet she works without any teaching or experience. Now, in all this she differs entirely from man, who only works well, perhaps at all, after being taught—who works with knowledge of what he is about—and who works, intending and meaning, and, in a word, designing to do what he accomplishes. To all which may be added, though it is rather perhaps the consequence of this difference than a separate and substantive head of diversity, the animal works always uniformly and alike, and all his kind work alike—whereas no two men work alike, nor any man always, nay any two times alike. Of all this I cannot indeed be quite certain as I am of what passes within my own mind, because it is barely possible that the insect may have some plan or notion in her head implanted as the intelligent faculties are: all I know is the extreme improbability of it being so; and that I see facts, as her necessary ignorance of the existence and nature of her worm, and her working without experience, and I know that if I did the same things I should be acting without having learnt mathematics, and should be planning in ignorance of unborn issue; and I therefore draw my inference accordingly as to her proceedings.

A. Come, come, Master B., I begin to surround you and drive you from your original position, maintained both now and last summer, about the impossibility of defining. Have you not as nearly as possible been furnishing a definition? At least, are not the materials of definition brought together ich you deprecated, and would have us reserve the last?

B. Patience, good man—patience! What is is to what you have gone through? Fancy urself once more in the House of Commons, on e Treasury bench, listening to ——— ———

A. God forbid!

B. Or suppose yourself again in Downing treet, with Drummond announcing a succession seven deputations or of seventeen suitors.

A. The bare possibility of it drives me wild. hy, to convert you to the most absurd doctrine could fancy—to make you swallow all the oonomia whole, and believe that men derive their ve of waving lines and admiration of finely-oulded forms from the habit of the infant in andling his mother's bosom, or even to drive you to a belief that the world was made by chance—ould be an easy task compared to the persuading y one suitor at any one of the offices that you ad any difficulty in giving him all he asks, or onvincing any one of those seven deputations that ere exists in the world another body but itself.

B. Or to convince any one man, who ever ked any one job to be done for him, that he had y one motive in his mind but the public good, which he was sacrificing his private interest. remember M. [Melbourne] once drolly observg, when I said no man could tell how base men re till he came into office, "On the contrary, I ever before had such an opinion of human virtue; or I now find that no man ever drops the least int of any motive but disinterestedness and self-lenial—and all idea of gain, or advantage, is the nly thing that none seem ever to dream of." But now compose yourself to patience and discussion—take an extra pinch of snuff—walk about for five minutes, a distance of five yards and back, with your hands in your breeches' pockets, and then return to the question with the same calmness with which you would have listened to a man abusing you by the hour in Parliament, or with which you looked an hour ago, in the Castle farm, at the beast you had bred, and which by your complacent aspect I saw you had sold pretty well.

A. But, indeed, I sometimes can't help fancying that it may be as well to take our observations upon Instinct from the operations and habits of such large animals as him you speak of—at least, not from insects; because it is possible that if we could see as accurately all the detail of the latter as we do of the former, much of the marvellous might disappear, and we might be as well able to account for their proceedings, which now seem to us so unintelligible, as we are to account for those of the greater animals, which are clumsy and cumbrous enough, and rather appear to proceed from an obscure glimmering of reason than from an inexplicable power guiding them unconsciously to work with the perfection which we ascribe to the bee. In a word, might not the cells be found to have as many imperfections, as great deviations from the true form, as any of the ox's operations have from perfect exactness, if either the bee were as large as the ox, or our senses as acute as the bee's? Has she not as great aberrations from the exact pattern in proportion to her own size and to the instruments, her feet and feelers, which she works with? I throw this out as a matter very *fit to be settled* in the outset, in order that our own reasoning may not proceed upon gratuitous assumption.

B. For the sake of ascertaining how far the working is as perfect as it appears, I admit the importance of your observation; but for nothing more. I deny that it affects the body of the argument at all; because that depends in no degree upon the perfection of the work. Thus the proceedings of the solitary wasp are just as good for my purpose as those of the bee. Nay, the instinctive operations of the greater animals furnish exactly the same materials for reasoning, though they may not be so striking. However, to the point of your comparison—you must keep in mind that we have applied the powers of the microscope to the operations of the bee. Now, without going to an instrument of the power of Torre's, which magnified the linear dimensions between 2000 and 3000 times, and consequently the surface above 6,000,000 of times, take the much more ordinary power of 400, which magnifies the surface 160,000-fold—nay, if you take a microscope of only a 90-times magnifying power, you will see the work of the bee in a straight line, exactly as you do that of a man with the naked eye. But, I need hardly add that, if you only saw it a quarter as well, or with a glass that magnified 20 times, it would be enough: for then you would examine it as you do the beaver's with your naked eye. But, further, all the difficulty you suggest proceeds upon a fallacy. The lines may not be exactly even which the bee forms; the surfaces may have inequalities to the bee's eye though to our sight they seem plane; and the angles, instead of being pointed, may be blunt or roundish: but the proportions are the same; the equality of the sides is maintained, and the angles are of the same size; that is, the inclination of the planes is just—in other words, all the inequalities don't affect the proportions of the parts; for they are common to each thing compared with another; the axis running through the inequalities (to speak more rigorously) is in the true direction, and the junction of the two axes forms the angle of 60° as accurately as if there were no inequalities. Now, then, the bee places a plane in such a position, whatever be the roughness of its surface, that its inclination to another plane is the true one required.

A. I suppose it is so; but, at any rate, the solitary wasp carrying the grubs in proper number and placing them in the hole over the egg, or the bee placing her egg in the liquor at the bottom of the cell, and making that cell of the length to which the worm when hatched will grow—she having never seen either the worm or the chrysalis—is sufficient for our purpose.

B. Not to mention the operations of the worm itself in spinning the cocoon, and making it precisely the size required to line or carpet the cell when expanded and applied to it—nay, the motions of the chick in the egg, which always begins at the same place, and moves itself on in the same direction, chipping away till it effects its own liberation—all of which must be prior to experience, and without the possibility of teaching.

A. You desired me last summer to examine, with a view to the same point, the ducklings hatched under a hen, and then taking the water, *without the* possibility of her teaching. They have the form, web-feet, &c., which enables them to swim, and which a chicken has not. Their manner of getting into the water I cannot say I well ascertained; but it is certain enough that the hen's proper brood would not have got in, and probably she would have succeeded in preventing them, though she might not be able to keep the ducklings out.

B. However, a more decisive case occurred to me afterwards: that of chickens hatched in the Egyptian ovens. I have lately seen an intelligent Bey and his aide-de-camp, who gave me the whole process; and, as was to be expected, there is not the slightest difference between the conduct and motions, and habits generally, of these chickens, and of such as are hatched and brought up by hens. This fact, as well as the working of the chrysalis in spinning the cocoon, and of the chick in chipping with its bill-scale, renders it quite unnecessary to inquire whether or not the honey-bee or social wasp work by instruction from other bees or wasps. That, however, appears to be impossible, when we consider that as many as 30,000 young insects come from one nest, to teach whom there are not old ones anything like enough; and to teach whom in a few hours, or even days, to work as exactly as themselves seems wholly impossible. The observation of cases where such teaching is impossible, as in the chrysalis and unhatched chicken, at once removes all doubt, and precludes the possibility of supposing that the wasp's and the bee's architecture can be traditional, or handed down by teaching, from the first insects of the species that were created. Henceforward, therefore, *we must* assume as part of the fact that the cells of the bee are made without any instr tion or any experience, and are as perfect at as they ever are; which, by the way, expl another peculiarity of instinct—that it never proves in the progress of time. The bee, 6 years ago, made its cells as accurately, and wasp its paper as perfectly, as they now do.

A. Let us advert to one thing more, and, ing settled it, the way may at least be said t cleared for the argument, perhaps somewha progress even to be made in the inquiry. have been speaking of Instincts in the plural course you do not mean to be taken literally admitting more kinds of mental Instinct than

B. Certainly not; any more than when sp ing of the mental faculties I admit of more m than one, or more parts than one of a single m This last form of speech has been so used, or ra abused, especially by the philosophers of Scottish school, accurate and strict as they for most part are, that they seem to treat the min divided into compartments, and to represent faculties as so many members, like the parts of body. But it is one thing or being perceiv comparing, recollecting—not a being of p whereof perception is one, reasoning another, recollection a third; so Instinct is one and i visible, whatever we may hold it to be in nature, or from whatever origin we may deriv This thing, or being, is variously applied, operates variously. There are not different stincts, as of building, of collecting food for fu worms, of emigrating to better climates—but Instinct, which is variously employed or direc *I agree* with you, however, that we have now something more than merely clearing away the ground. We have taken a first step, or, if you will, laid a foundation. We have ascertained the peculiar or distinctive quality of Instinct, and that which distinguishes it from Reason. It acts without teaching, either from others, that is, instruction, or from the animal itself, that is, experience. This is generally given as the definition or description of Instinct. But we have added another peculiarity, which seems also a necessary part of the description—it acts without knowledge of consequences—it acts blindly, and accomplishes a purpose of which the animal is ignorant.

A. I pause here and doubt of this addition. I perfectly admit the fact that it produces an effect, manifestly the object of its operation, and yet without knowing it, consequently without intending it or designing it. But there seems reason to think that it always intends to produce some one effect, and does produce it—that it has some one purpose, and accomplishes it, and so designs something which it does. Thus animals are impelled by hunger to eat; their eating produces chyle, blood, and all that is secreted from the blood; yet they had no design to promote their own growth and preserve their own life. At least they ate long before they had any such design or any knowledge that such would be the consequence of gratifying hunger. So of continuing their species. May not the solitary wasp, for instance, have its organs and its senses so constructed as to receive an immediate gratification from collecting and burying grubs? If so, her knowledge extended to one, the first, event, and she had the design in view of producing this event; though wholly ignorant of any subsequent event. The desire of the first event, the fact of that event being a gratification to the insect, was the means taken by the Creator of the insect for making her do that which was to produce the important consequence, forming the real object in view, though concealed from the animal. Thus we may conceive that the insect is endowed with an appetite for carrying grubs, and that this is so adjusted in point of intensity as to be satiated when just so many grubs are transported as will feed the next season's worm, which is endowed with the desire to eat these grubs, rejected as food by the parent insect. So the wasp's senses may make the flavour, or the smell (for that seems all she enjoys), of a living caterpillar more grateful than of a dead one; and hence she takes those that will keep sweet till her own grub is hatched.

B. I do not deny the possibility of all this; although there seems something gratuitous in it, and we possibly never can know the truth by any observations or experiments. I shall presently show why I do not think it would entitle us to erase this ignorance of what you would call the second event, or the object of the secondary design, from our list of the characteristics of Instinct. But in the meantime I will mention what occurs to me on your objection in point of fact. The instant that a solitary wasp is hatched, or a bee can fly, away they go to the spot where the caterpillars or the wax-yielding substances are to be found. What guides them through the air to things they cannot descry or do not know the use of?

A. It costs me no more to suppose that there is *some smell* or other sensation to guide them—some dour, for example, which penetrates the air, and eing grateful to them makes them desire to approach the odoriferous body. Thus the bee smells he nectary of flowers; she flies to them, she sips, nd the wax is secreted in her stomach. I grant you that I have more difficulty with her operation in using it.

B. You clearly have; for what should be the special gratification of that? We are admitting that she has no kind of knowledge that the cell is to be used in hatching and rearing the brood, any more than that an hexagonal figure, with a certain inclination of its rhomboidal bottom, is to enable her and her associates to employ the space and the wax in the way of all others most economical of room and work and materials; and so as just to accommodate the size of the unknown and unseen worm, chrysalis, or young bee, and no more—and also to suit its form.

A. I think I could suppose also in this case that her desire of action—her love of motion—is gratified by the operation, and is satiated by continuing that motion to a certain extent, where she stops.

B. But allowing your right to make all these suppositions equally gratuitous, one after another, nd to extend them as the argument proceeds, and o relieve the pressure as the fact pinches—see what it is that you must assume. The comb is onstructed thus. Wax-making bees bring a small mass of this material and place it vertically to the plane from which the comb is to hang down. Then other bees begin to excavate, one on one side, another on the other, and they work with such perfect nicety, as never to penetrate through the thin layer of wax; also so equally that the plate is of equal thickness all throughout, its surfaces being parallel. You must, therefore, suppose some repugnance at once to a plate ever so little thicker, and to one ever so little thinner than the plate's given thickness. Indeed, this supposition, which some naturalists have made, is wholly unsatisfactory, and shows no accurate regard to the facts any more than their notion (a most crude one) that the hexagon cells arise from so many cylinders pressing on each other. The supposed instinct not to perforate wax, but to draw back when they come to a given thickness, is inconsistent with the fact; for the original plate they work on is uneven and of different thicknesses on both sides, and there is no bee in the world that ever made cylindrical cells. Huber has distinctly shown, from having observed them at their work, that they make them in quite another way; nor indeed, if they did, could any pressure ever produce hexagons, and far less rhomboidal plates. The wax-worker's bringing plates of a given thickness is also wholly incapable of accounting for the angles, that is, the inclination of the plates—for supposing the bee to make a groove (as she does), and suppose she has some means of bisecting its arc by two chords, this only, with the thickness of the cake, would determine the depth of the rhomboid, and that can be easily shown not to be the rhomboid actually made. She therefore makes angles wholly independent of the thickness, not to mention that were we to admit that the cake's thickness governs the whole, we do not solve the problem; the difficulty is only removed a step; for then how is that exact thickness obtained? But this will not do even to that extent; a great deal more is done by the bee, and a

at deal more must be supposed to make it con-
vable that she has any immediate or primary
ention. She works so that the rhomboidal plate
y have one particular diameter and no other,
l always the same length, and that its four angles
y be always the same, the opposite ones equal to
h other, but each two of different quantity from
other two; and then she inclines the plates at
en angles to one another. Why is there such a
tification to the bee in a straight line—in a
aight line at right angles to a plane—in rhom-
ids—in rhomboids with certain angles—any more
n in lines or planes inclining at other angles to
another? Why is the bee, after working for
lf a quarter of a line in one direction, to go on,
l not take delight in a change of direction? If
goes on, why is she to be pleased with stopping
one particular point? Nay, why is each bee to
e delight in its own little part of the combined
ration? Why is each to derive pleasure from
ng exactly as much as is wanted, and in the
ection wanted, in order that when added to what
ers have before done, and increased by what
ers are afterwards to do, a given effect, wholly
known to her and to all the rest, her coadjutors,
y be produced?

A. It certainly is difficult to say. I can barely
agine the different bees so formed that some in-
plicable gratification may be the consequence of
ving in one line, and making one angle, and that
y other line or angle whatever may be disagree-
le to them. The concert in the operation of
imals seems to increase this difficulty much,
ways supposing there is real concert without any
angement, communication, or knowledge. No

man ever acted so as to make his operations chi in with another's, unless he either had previ concert with that other, or both acted under a cc mon superior, and obeyed his direction; and tl the joint operation was that of this superior.] suppose a man were compelled by some feeling could not account for, and did not at all understa to go at a given time, to a certain place, and w such speed as to arrive there at a given mome and were to find another just arrived there, v came to meet him without the former previou knowing of this,—we should have a case similar that of animals acting in concert, supposing th to do so. There is, however, some doubt of this to the bees; for Huber has said that they all in succession rather than co-operate contempo neously.

B. I really can see no difference that this ma in the argument as to concert. One bee brings v and does not sculpture; another sculptures and d not bring wax; but the wax-worker brings just much as the sculpturing bee wants, and at the v time she wants it; also, one works on the face, a another on the back of the same rhomboidal pla and all so work as never to interfere with or jo one another, which is the perfection of concert, a can only among men be effected by discipline, wh refers the whole of the different purposes to (superintendent, and makes his unity of design guiding rule and impulse, because concert amc the different agents is otherwise unattainable.] I own I can see no greater difficulty thrown in (way by concert than by blind agency—suppos it blind as to both the events, and not merely bl *as to the* secondary consequence—and your sup sition of a first event known and designed, the secondary being hidden from the animal, would, I think, account for a case of concert, as much as for any other operation; for your hypothesis of sensations and impulses would apply to concert. You might say that each bee was induced by the gratification of doing a certain thing, to take a certain line at such a time; that what it did should answer to what some other bee was by the like means induced to do at the same time. I see no difference in the two applications of this hypothesis.

A. I rather think the time makes some difference; at least in rendering an addition to the hypothesis necessary. For though the gratification of bringing the caterpillars to its nest will account for the solitary wasp doing what is also to serve the purpose of feeding its young next season, something more is required than this motive to make one bee act in concert with another; it is necessary that there should be a gratification, not only in doing the thing required, but in doing it at the very moment required; so that both bees must be supposed to feel at the very same instant of time the desire of the gratification in question, and yet without any concert or communication. I hardly see how my supposition of sensations and pleasures or pains will explain this.

B. I all along have seen the greatest difficulty in your explanation; but does this consideration of time increase it materially?—or rather, is it not in all cases part of the riddle which instinctive operations present to us? Thus the solitary wasp acts, that is, according to your hypothesis, feels the given sensation or derives the supposed gratification at such precise time that her acting upon it will suit the time required for the birth and growth of the worm. The bird breeds,—but before laying her eggs, and without any knowledge when she is to lay them, makes her nest, and it is ready at the very time required. Therefore she feels the desire of nest-making at the proper moment. I will admit, however, that there is something still more extraordinary in two separate and independent insects feeling the same impulse at the same moment; and the difficulty is incalculably augmented, if twenty or thirty insects all have the impulse separately, but all at once, so as to act together. Indeed, I cannot help regarding your solution as not only a gratuitous hypothesis, for that it must needs be from the nature of the thing, but one hardly conceivable, and in truth as difficult to suppose possible as any other thing which we can fancy in order to explain the phenomenon—for instance, some invisible power or influence acting upon the animal, or upon the different animals at once. This is not at all more gratuitous, and it more easily explains the phenomenon.

A. Consider if there is really any such essential difference between the case of instinct which we have been considering, and any of the best known operations of men, as well as animals, where we are not wont to speak of instinct at all. Thus men eat from hunger, which they intend to satisfy; but the consequential effect, not intended, is chylification, sanguification, secretion, and growth or sustentation of the body, as well as the effect intended, and immediately produced, of satisfying hunger. The mother eats things which satisfy her appetite, and that is all she cares for; but those things also produce milk, which nourishes her infant, and that she never thought of. The time is also suited by the feeling. The hunger gives the supply when the system wants it; the eating produces the milk when the infant requires it. How does this differ from the other case?

B. Much every way. The difference is wide and marked. In the cases you put, the mental instinct is confined to produce the effect intended; and having produced it, the mind stops there and does nothing more. The powers of matter, its physical qualities, set in motion, do the rest, of course beyond our direct control, and unaided by us as unknown to us. But in the case of Instinct the mind performs both parts—both the things which it knows and intends, and the thing which it neither knows nor intends. The mother eats—nature produces the milk without the least action of hers. But the bee not only gratifies herself (if that is the cause of her architecture) by the structure of the cell, but by her art, by her work, she does the other thing also, that of providing a lodging for her young. It is as if the mother in your supposed case were both to eat intentionally for satisfying her hunger, and at the same time, without knowing or intending it, were to make milk by some process of internal churning. It is as if in eating we at once chewed and swallowed, and also with our tongue or teeth or fingers made chyme, and then chyle, and then blood. It is as if the animal in pairing both gratified his sexual passion and voluntarily made the young by some process of manipulation, though without knowing what he was about, or intending to do it.

A. You must here distinguish a little, or rather you must take into your account a point of resemblance which you are passing over. How can a one even acting with design affect matter in fashio ing it or moulding it, except by availing himself the powers, mechanical or chemical, belonging matter? If I distil, it is by availing myself of t process of fermentation and of evaporation, and condensation. If I sow and reap, it is by availi myself of the prolific powers of heat and moistu in the process of vegetation. So even in process where I seem to do more and nature to do less; I build, or carve, or weave, it is by availing mys of the qualities of cohesion and gravitation, and the powers of the wedge in hewing, or of friction polishing. Do not the animals who eat, the m thers who give suck after eating and thereby secre ing milk, in like manner do part themselves, and to the rest avail themselves of the powers of natu in chylification, sanguification, and secretion? Y perceive how much more nearly akin the cases a than you have stated.

B. I am well aware of it; indeed, we are n coming nearly into the controversy about produ tive labour, which you and I have often amus ourselves with as political economists; when I ha always held that it was a far less easy thing th those who discussed the metaphysical parts of t science supposed, to draw the line between prod tive and unproductive labour, either by includi manufactures or only commerce in the latter—a agriculture alone or with manufactures in the f mer, the productive class. Be it so: I am conte if there be as marked a distinction here as betw the labour which produces or moulds matter int new substance, and that which only exchanges *thing* for another; or defends the community, administers justice among its members. But, in truth, we have, in our present argument, a specific difference, admitting all that you have urged, as to the affections and properties of matter being used by the animal in both processes. The great and broad difference is this. In the one case, as in the wasp carrying the caterpillar to its nest, which she does and means to do, or, if you will, gratifying her senses with the carrying, whatever instruments she works with, she does the thing knowingly and intentionally; she does it by means of gravitation and cohesion, but still it is she, her action, her will, her mind that does it. In the other case, that of leaving the caterpillar in the nest for months, she has done; she quits the work; nothing she does is at all conducive to the operation then performed by nature; but what she did was all that could be done excepting by nature. So the mother eats the galactigenous matter, and then has done; nature does all the rest. But there is this material difference in what the bee or the wasp does,—that she finishes the whole operation voluntarily; it is as if the mother were not only to become gravid, but to prepare the child's clothes and habitation herself, and yet to do this without knowing what she was about, and while she intended to do, and thought she was only doing, some perfectly different thing. If, indeed, you put the case of a person ploughing and sowing for the purpose of strengthening his limbs or amusing himself, and not meaning anything to grow, and also ignorant that anything will grow, and yet choosing the seed which will grow, and sowing it at the right time to make it grow—then you merely put the case of Instinct in other words; and the one thing will be as difficult to cillate; all these things are the direct and uninterrupted agency of the property which the Deity has impressed on matter at its creation; perhaps, of the laws which His power perpetually maintains. But they are wholly unconnected with any animal workmanship of any kind; they have no subordinate mind to guide them; nor can any act of ours, or of any animal, affect them. On the contrary, in all our operations we must conform to them.

A. Unquestionably it is so; and this is the distinction, and the broad one. But then it follows from the preceding deductions, that we must consider in the works of Instinct the animal acting as an agent, though ignorantly and unintentionally,—a tool or instrument blindly used to do a certain thing without its own knowledge or design; and the tool being a living thing, the mind is the instrument. In the case of matter, the matter is the instrument blindly serving the purpose by obeying the physical law. In our case the mind is the instrument, and obeys the mental law as perfectly and as blindly.

B. There is one thing, however, always to be considered. We have hitherto been viewing Instinct alone, and arguing as if animals always acted by it, and never otherwise. Now this is quite impossible, at least in the sense in which we have taken the word Instinct. There may be some doubt if we are right in so limiting the term, though I have a very clear opinion that we are. Paley and all or almost all others define Instinct to be a disposition or acting prior to experience, and independent of instruction. But among other *objections*, there is this one to the definition, that it amounts to saying "an acting without knowledge," and yet does not say it. There may be no experience, and yet no Instinct, *e. g.*, we may act on the information of others—but then what shall be said of the information given by reasoning; that is, by our inferences from our own thoughts? This is plainly not instruction. Is it experience? If so, the definition seems only to say, that Instinct is anything that is not reason, in other words, that Instinct is Instinct. But I apprehend, when we speak of instinctive operations we always have an eye to some end which is blindly served by the act—some act done by the animal, in which he does what he does not mean, and in doing which he is a blind instrument.

A. How is it when we speak of instinctive desires?

B. I should say we then mean something different from merely animal or natural desires, for that would make every thing instinctive. We mean desires which are subservient to some purpose towards which they move: some end beyond the doing the act seems always involved in our notion of Instinct. We do not call mere moving, yawning, stretching, instinctive; and when we speak of sucking or eating, and the desire or power to suck or eat, as instinctive, it is surely with a regard to the subserviency of those operations to support life that we so term them. If they did nothing for our frame, we might call them natural, hardly instinctive.

A. But be this as it may, no one can doubt that animals, if we allow them to have these Instincts, and to act for ends unknown to themselves, have other actions of a kind resembling our own, and quite distinguishable from what we have been calling Instincts; therefore it signifies little whether or not we are right in giving the name to actions accomplishing undesigned and unknown purposes, provided we keep that definition in view. These animals also have other actions, where they both know and intend and accomplish their definite object.

B. Undoubtedly, they have many such in which their operations of mind and body cannot be distinguished from our own. Now whether these are under the guidance of faculties like ours; whether they have reason; whether they have faculties differing from our own in kind, or only in degree —we need not at present stop to inquire. It is quite enough for us that they have two kinds of operations, one which we agree to call Instinctive, distinguished by the ignorance of the object and want of intention; the other both knowingly and intentionally done: so man, acting almost always rationally, also acts in some rare cases unintentionally—chiefly in early infancy.

A. There may be instinctive acts with knowledge, and there may be acts not instinctive without knowledge. Does not this break in upon the definition which excludes knowledge as well as design? Many parts of human conduct seem to be guided by Instinct, and yet with knowledge.

B. This would no doubt overturn the definition, provided it be clear that "*knowledge*," and the "*presence of knowledge*," are here used in the same sense as in that definition. But we must make a distinction. There is a knowledge of some *end* or *object* in view, and a knowledge of the *means* whereby that end or object is to be attained;

in other words, of the *mode* of *operating*—of the *process*. There is also a distinction to be taken between instinctive *desires* and instinctive *operations*. The objection you have now made refers to the former—to desires; the latter, the operations, are chiefly referable to the great question respecting the controlling mind, or actual interposition of the Deity, to which we are approaching; but it also refers, in some measure, to the objection which you raise. Knowledge of consequence comes within the description of object or end; and if there be no intention to attain an end actually pursued, there can be no knowledge of it; and conversely, if there be no knowledge of it, there can be no intention to attain it. Take any instance of what you call human instinct, as hunger, or the sexual passion—these are desires, and their gratification may be pursued without any knowledge of, and consequently without any view to, the consequences of making chyle and blood to support the individual, or offspring to continue the race. As far as the mere gratification of the desire or supplying of the want goes, we may be said both to know what we are doing and to intend or mean to do it. We are attracted by our senses, that is, by the effect of our senses on our minds, to do certain things; and this is called instinctive acting,—I apprehend incorrectly. It is *natural* desire, but why instinctive? When we say Instinct, do we not mean something beyond this? Desires may be subservient to Instincts; but are they all we mean by Instinct? They may lead to the attainment of a certain end; they may be the way in which Instincts operate: but are they themselves Instincts? If two foods are presented to an animal, a man for example, who knows nothing of either; and he is impelled, without knowing why, to take the one and reject the other, and the one is wholesome and the other a poison; we at once call this the operation of instinct, which some define to be knowledge without instruction or experience, but which I have wished rather to call mental action without knowledge, or at least independent of knowledge. So in Galen's beautiful experiment on the kid just born, having been taken out of the mother, and which of course had never sucked, when, upon many shallow pans with different liquids being placed near it, the animal preferred at once the pan containing goat's milk. If the reason for the preference is some greater gratification of the senses, or that the one food is pleasing, for instance, in smell fragrant, and the other offensive, this may be the mode taken by nature to make Instinct operate according to your former hypothesis, which we have been discussing at large; and we certainly cannot tell that such may not, in all cases, be the mode taken by nature for working to the same end. It seems, however, eminently unlikely that the whole operations of bees, for example, should be owing to the pleasure their senses receive from one particular form and proportion alone, and a repugnance to all others, because of their being disagreeable to those senses. But do we not, in all cases, mean, by using the word Instinct, to point out the unknown connexion between the thing done and something else of which the animal—the agent—is not aware? I grant you that we speak of Instinct of hunger and Instinct of sex; but is not this only a way of saying, and do we not mean, merely desire of food or sex, the gratification of which is a natural propensity, and known and felt by us to be such? Thus it is an Instinct which makes animals propagate their kind while they merely mean to gratify their passions, and which enables them to prepare a nest, and have it quite ready at the very time they are to want it for laying their eggs in. We always seem to have the *motive*, the *end*, and the *blind instrumentality* in our view when we speak correctly of Instinct. I may intend to do a thing, and know both the object in view and that portion of the operation or process which depends on me—*e. g.*, to eat for the purpose of making chyle. My ignorance of that process, with which I have nothing to do, would not make the operation of mine be called an Instinct. Indeed, even if I eat to satisfy hunger, without any design of supporting the system, this act is not instinctive, except in so far as doing and meaning one thing, I am doing another thing ignorantly and unintentionally.

A. I think we have got as far as we can in these preliminary discussions and observations of Facts, and may now proceed to Theorize and infer.

B. However, we are come, or coming, to a part of the subject where we should be among our books; for we shall now have to look at them in proceeding further. At least, it is as well we should observe what has been held on this matter by philosophers. So we had better adjourn for the present; and resume our conversation in the library, if indeed you, who are accustomed to Althorp and Spencer House, can condescend to call anything in this part of the world by that name. We commonly, from feeling this modesty, name it the Book-room.

A. And I dare swear, also from your love of the Saxon idiom.

B. Possibly; though I would that our good old English never suffered more havoc than by calling Book-rooms Libraries. I expect to outlive it, as Serjeant Maynard said he had nearly done the law, with the lawyers.

BOOK OR DIALOGUE II.

INSTINCT.—(THEORY.)

HAVING thus far carried on our discussion in the open air, we removed, towards the afternoon, to the library—"cum satis ambulatum videretur, tum in bibliothecâ assedimus"*—and there conveniently pursued the subject, which greatly interested us both.

B. The manifest difference between Instinct and Reason which we have been observing, and its regular and constant action, always the same, and never improved, but never different, indeed apparently incapable of improvement, was probably the consideration which induced Descartes to consider animals as machines.

A. I am aware that this is commonly said of him. But I know not how that great man could really have held so untenable a position. Did he really consider them as mechanical contrivances—as mere physical substances, without anything answering to what we call Mind?

B. He is always so represented; but when you examine his own statement closely, you really find that this is an exaggeration, and that his doctrine differs not very much from that commonly rec As has oftentimes happened to others, his ments are rather taken from the statement of by those who were controverting them, than his own words.

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* "When we thought we had walked long enough, we took our seats in the library."—Cic. de Div. ii.

A. Where are they to be found?

B. Look here—you have them in the treatise on Method, the introduction to his on Dioptrics and Meteors. He dwells on having no gift of speech, which yet require little reason, he says; and therefore he con not that they are less rational than man, plane esse rationis expertia." * Thus far no can exist; he only gives a very common o on the subject, though an opinion controvert some, as I shall hereafter ask you to discuss: forms a head distinct from our present in But a little way further on he proceeds to trate his position in a manner which has give to the notion in question. "They do many t even better than ourselves," he says, "bu does not prove them to be endowed with r for this would prove them to have more r than we have, and that they should excel us other things also—but it rather proves them void of reason, and that nature acts in the cording to the disposition of their members, see a clock, which is only composed of wheel weights, can measure time better than we can with all our skill." He goes on to show that the interests of virtue are greatly injured by the belief, not that brutes have souls, but that they have souls like our own—"brutorum animam ejusdem esse cum nostrâ naturæ,"—and that therefore we have nothing more to hope or fear in a future state than flies or ants; whereas he had shown our souls to be by their nature independent of the body, and therefore not mortal like and with it. All this you perceive is anything rather than the doctrine that brutes are mere machines.

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* De Methodo, 36.—" Istud autem non tantum i bruta minore vi pollere quam homines, sed illa pla rationis expertia. Videmus enim exiguâ admodum esse ad loquendum."

(Of Method, 36.—" But that not only indicates that have less power than men; it also proves them to be reason. For we see that very little reason is requi *enable men to speak.*")

A. But where do you find the adversary's representation of it which you mentioned?

B. Here, in this other and very curious volume, containing his Correspondence with many learned persons, and some less learned, as Christina, Queen of Sweden, and our Princess Elizabeth, the Electress Palatine and stock of our present Royal family, to whom he writes, among other letters, one on her brother Charles the First's execution—which, to console her, he praises as more glorious than an ordinary death—"pulchrior, felicior, et dulcior."*

A. Does the Princess enter on the question of animals?

B. No; she seems to have been ailing with fever, and having been light-headed, she applies to the philosopher to explain to her how in the night she felt an irresistible desire to make verses: this he courteously explains (after saying it reminded him of a similar anecdote related by Plato, of Socrates), that it is owing to the agitation of the animal spirits, which in weak brains produces madness, but in strong ones only a genial warmth, leading to poesy, and thereupon he holds her Serene Highness's case to be "ingenii solidioris et sublimioris indicium."*

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* "Finer, happier, sweeter."—Epist. Pars I., Ep. xxvii.

A. Upon my word, I shall begin to think a person who could thus theorize as well as flatter about animal spirits and Serene Highnesses, was capable of shutting his eyes to the most ordinary facts, and believing brutes to be machines.

B. Do not undervalue this great man: he is the true author of all the modern discoveries in mathematics. He made the greatest step that ever man made since the discovery of algebra, which is lost in the obscurity of remote ages: I mean his application of algebra to geometry, the source of all that is most valuable and sublime in the stricter sciences and in natural philosophy. But assuredly his physical and psychological speculations are much less happy; although it was no mean fame to be the author of a treatise, the answer to which was the first work ever composed by man—Newton's Principia. But I was coming to the controversy on Instinct. An ingenious clergyman of Cambridge, Henry More, objected to the doctrine of the great philosopher, as laid down in that treatise to which we have been referring, on Method; and he began by describing the doctrine as denying sense and life to brutes. He speaks of Descartes's genius, "chalybis instar rigidum et crudele, quod uno quasi ictû omnium ferme animantium genus vitâ ausit sensûque spoliare in marmora atque machinas vertendo."† This he repeats in various ways, and argues against, as the doctrine of Descartes.

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* "The proof of a more solid and more lofty understanding."

† "Rigid and heartless like steel, which, as by a single

A. Nothing in what we have read out of Descartes' own writings justifies this. Is there any other passage to which More can allude?

B. He refers expressly to the passage in the "Tractatus de Methodo," and discusses the argument there given from the want of speech. But there remains a letter of Descartes to a certain great personage (ad Magnatem quendam), in which he repeats the doctrine of the treatise at somewhat greater length, but using the same comparison of a clock, and using it as a comparison. His whole contention is, that they, the brutes, have not reason like us, which he terms sometimes "intellect," or thought—"intellectum vel cogitationem." But that he means reason, and does not mean to assert that brutes are machines, seems plain from this, that in the same passage he allows them natural cunning, or craft, as well as strength—"imo et puto nonnullos (animantes) esse posse quæ naturalibus astutiis instructæ sunt quibus homines etiam astutissimos decipiant."* This is anything rather than describing them as mere machines.†

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stroke, can deprive almost all animals of life and sensation, turning them into marbles and machines."—Epist. Pars I., Ep. lxvi.

* "Nay, I also think there may exist some brutes endowed with natural cunning to deceive the most cunning of men."—Epist. Pars I., p. 107.

† He afterwards, in the same letter, says, that although brutes do nothing to show they can think, yet it may by some be supposed that as they have limbs like our own, so thought (cogitatio) may be joined with those limbs, as we know it is with our own, although in them the thinking principle (cogitatio) may be less perfect than in us. "Ad quod," says he, "nihil est quod respondeam nisi quod si illa

capable of imitation, of learning, and of much cunning—and a body animated by a mind? To speak of sensation as depending upon the corporeal organs is either unintelligible or it is a begging of the question, and the very same definition might be given of our own sensation—nay, is given of it by the materialists, who hold our mind to be the mere result of a physical organization. Yet with these Descartes differs more indeed than with all others.

A. I cannot help thinking, on the whole, that it is very possible this great man may have only meant to deny the brutes a reason, or mind like ours, a power of ratiocination, and not to consider them as mere machines. But I am clear of one thing, that if he did mean the latter, a more untenable doctrine never was broached upon this, or indeed upon any other subject.

B. We may therefore, I conceive, pass over this theory altogether. But another and a greater man has been so pressed with the difficulties of the subject, that he has recourse to a very different supposition, and instead of holding the Deity to have created brutes as machines without any mind at all, he considers their whole actions as the constant, direct, and immediate operation of the Deity himself. Such is the doctrine of Sir Isaac Newton, which is saying enough to prevent any one from hastily rejecting it, or rashly forming his opinion against it.

A. Does he not mean merely to derive the actions of brutes from a perpetually superintending and sustaining power of the Deity, as we ascribe the motions of the heavenly bodies to the same constantly existing influence? He probably only *means that* the brute mind, having been created, is as much under the Divine governance as the material powers, qualities, and motions are: in other words, that mind was created, and matter was created; and that still the actions and passions of both are constantly under the guidance of the Creator. So that Sir Isaac Newton would no more deny the separate existence of the minds of brutes, than he would the separate existence of their bodies, or of the heavenly bodies.

B. Here are his own words. The passage occurs in the famous 31st Query, or General Scholium to the Optics;* and you see that, after recounting the structure of animal bodies as proofs of design, he adds, "And the instinct of brutes and insects can be the effect of nothing else than the wisdom and skill of a powerful, ever-living agent, who, being in all places, is more able by his will to move the bodies within his boundless uniform sensorium, and thereby to form and reform the parts of the universe, than we are by our will to move the parts of our bodies." He proceeds to guard the reader against a supposition of the Deity being the soul of the world, or of brutes, or of His being composed of members or parts, stating that He only "governs and guides all matter by his prevailing power and will." So that you see he draws the distinction between the mind or will of men, which influences the motions of their bodies, and the influence which moves brutes; plainly enough referring the latter to the Deity himself, as the *primum mobile*, or actuating principle; for he allows that the kind of ubiquity or universal action to which you refer applies to our bodies, and I presume to our minds also, which were created and are sustained by Him. Of that no doubt can exist, because elsewhere he has laid down as clear this ubiquity, called, as you know, *essential* ubiquity, to contra-distinguish it from *potential* or *virtual*. You find this plainly stated in the Principia—here is the celebrated General Scholium: "Omnipresens est non per virtutem solam, sed etiam per substantiam"—"In ipso continentur et moventur universa, sed sine mutuâ passione."* Therefore it is quite manifest that, in here treating of Instinct, that is, of the operations of animals, he considers the Deity's action as different from that general direction which he ascribes to Him over matter and mind by His essential ubiquity. In other cases He acts on matter and mind, and in the case of mind, He acts on matter mediately or through the agency of mind, which mind He moves. But here He acts, according to Sir Isaac Newton, directly on matter, and is the moving and acting principle of animals; and such has generally been the construction put upon his words as you have them here in the 31st Query. It has been so stated by so popular a poet as Pope, and also, though with less precision, by

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* There is nothing more admirable for extent and generalisation of view than this 31st Query. The happy conjecture respecting the nature of the diamond in the 2nd Book (Part II., Prop. 10), does not surpass the wonderful sentence in the query, where Sir Isaac Newton classes together, as similar operations, respiration, oxydation, and combustion. These have since been discovered to be the same process. In Sir Isaac Newton's time, their diversity seemed as great as that between the diamond and charcoal.

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* "He is omnipresent, not virtually alone, but substantially"—"In him all things are contained and moved, but *without* mutually affecting each other."—Principia, lib. iii, *Sch. Gen.*

Addison. The former takes the distinction, in his Essay on Man, between brutes as only having volition, which in them acts for both willing and reasoning: while men have the double faculty. He expresses himself with his wonted felicity:—

> " See then the acting and comparing powers,
> One in *their* nature, which are two in ours;
> And Reason raise o'er Instinct as you can,
> In this 't is God that acts, in that 't is Man."
> *Essay*, *Ep.* iii.

Addison, in his 120th Spectator, after giving many instances in which he jumbles together Instinctive and Intelligent operations, concludes with the remark, that "they can no more be explained than gravitation can; and come not from any law of mechanism, but are an immediate impression from the first mover, and the Divine energy acting in the creature."

A. This dogma of Newton is certainly great authority—the greatest human authority. For it is the opinion—and, regard being had to the awful nature of the subject as well as the contemplative and religious nature of the man, it is probably the well-considered opinion—of the greatest inquirer into nature that ever existed, and whose conjectures have been almost as happy, and are certainly quite as marvellous, as his complete discoveries.

B. Observe, too, that it is the opinion of his maturer years. The Scholium to the Principia was added in the later editions—when written does not clearly appear, but the second edition was published in 1713, and the third as late as 1726. The 31st Query to the Optics was added at a time which can be fixed better. The first edition of the Optics, published in 1704, had not the queries. The second, published in 1717, had them; and the third edition was corrected by the author's own hand a short time before his death; from which corrected copy the one I am now citing was printed in the year 1730, after his decease. But as he first published this passage in 1717, and was born in 1642, he was then in his 75th year, and had long before made all his discoveries.

A. I quite agree that as far as mere authority goes, no opinion ever had so great a weight—nevertheless we have the same illustrious man's authority, and example too, to teach us that it is by our own reason alone that we ought to be guided in philosophizing, and we must bring to the test of that canon even HIS best considered opinions.

B. This I of course freely admit. Let us, then, examine a little this doctrine of immediate interposition—which regards the work of the bee, for instance, as the direct and immediate operation of Divine wisdom and power.

A. I need hardly warn you against being seduced by another bias, as powerful as Sir Isaac Newton's authority—the disposition we must have, if possible, to believe in a doctrine which, by exhibiting the finger of God as perpetually moving and working before our eyes, seems to bring us constantly into His presence, as if we saw a perpetual miracle wrought, and almost enables us to commune with the Deity, as the Patriarchs did of old. The gratification to us, as men, of reaching this position, should not make us, as philosophers, open our ears the more readily to any unsound or inconsistent reasonings, assume facts on slight grounds, or, passing over flaws in the argument, receive easily *erroneous* conclusions from what we see.

B. Again I entirely agree with you. Far from making greater haste to reach a position so delightful, I should take the greater care of my steps, that I might not slip and fall by the way: for that the road is slippery, the light glimmering, and the route over high ground, leading through precipitous passes, must, I think, be admitted freely. But let us step on cautiously as we have hitherto done.

A. We left off with the deduction that brutes act from a principle, a thinking principle, a mental principle, something different from their bodies and from surrounding objects, but that they act towards an end of which they are ignorant, and accomplish that end without design, though very possibly they may also in so acting accomplish some intermediate end of which they are aware, and which they intend to attain.

B. We may add another thing to the proposition. The end which they accomplish blindly and instinctively is far the more important of the two, admitting that there is another and intermediate one. For, suppose your theory to be correct, that the solitary wasp gratifies some sense in carrying caterpillars and the bee, in making hexagons and rhomboids, it is plain that this is a very trifling matter; it neither feeds, nor clothes, nor lodges her, nor her brood; whereas, the purposes to which those works are subservient are the continuation of the species of the insects respectively—the greatest and most favourite end in nature.

A. True; and you may add another thing, which I allow, even if my theory be ever so certainly correct—that the only possible use of the intermediate end is the accomplishment of the other end—for if you grant me that the wasp carries caterpillars, and the bee makes geometrical figures, to please themselves, or gratify some sense, it is of no importance that either should receive that gratification: its only use is the unknown and unintended consequence of providing for the unborn issue.

B. We are now then arrived at a very important height, from whence we may survey the subject correctly and advantageously.

A. Let us be quite sure that we have left no obstructions, or rather that we have passed over nothing material—that we have left no objections in our rear, which may rise up and mock any inference we now draw. For instance, are all our facts clear? As to the bee's architecture, some have questioned the theory. I have heard it said that what seems so perfect a structure, and so judicious a dividing out of the space, so as to save room and work and material, is only the necessary consequence of placing a number of cylindrical or globular bodies together; that if you blow many soap-bubbles in a basin they will, by their weight and pressure, settle into hexagons.

B. There never was anything more absurd than what some, calling themselves philosophers, have said without a moment's reflection on this subject. No less a name than Buffon may be cited for such nonsense. There are two decisive answers:—*First*, the soap-bubbles will not make hexagons, although your eye may see straight lines formed by their intersections, but not one hexagon the least like the bee's will you find in all the foam; and *next*, there is not a single globe, or cylinder, or any figure like it ever made by any bee. Huber has seen them, or rather had them carefully observed, when at work;

they first make a groove, and then form its walls into planes, and all the rest is a making of planes and angles one after the other without any circular figures at all. So some one finding the eye of the bee to be a net-work, when greatly magnified, and each mesh a hexagon, thought he had found out why the bee works in that figure. To which the answer was obvious, that men and other animals having circular pupils should, by parity of reason, work in circles. But another answer was just as decisive; that the light entering by a hexagon almost infinitely small no more helps the bee to that figure than if it entered by a circle or a square. Its paws and feelers are to work. Nay, suppose even it had a small pattern hexagon ready made, would its working a large one on that model be at all less wonderful? Not to mention that the hexagon is not the greatest wonder; the rhomboidal bottom of the cell, and the angles which its three plates form with each other, and with the walls, are the wonder, and no one pretends to account for that. I pass over the form of the limbs; nothing can possibly be deduced from them in the smallest degree fitted to aid the bee in her marvellous work.

A. Have not some sceptical inquirers thrown other doubts upon the mathematical part of this great wonder? I think I have heard something of the kind, as if Maclaurin, or whoever was the discoverer, had rather been fanciful, or over-refining, and that the bee had turned out to be not so good a geometrician as they had supposed.

B. Here is a sample of those doubts—though they are not indeed, like Newton's sound conjectures, stated with the modesty of doubts—but somewhat dogmatically. It was the celebrated Maraldi who first measured the angles, and found them to be 109° 28′ and 70° 32′ respectively. Réaumur afterwards set a young mathematician, pupil of Bernoulli, called Kœnig, to find what were the angles that made the greatest saving of wax, and the result was by his analysis 109° 26′ and 70° 34′, being within two minutes of his own measurement, which measurement he had not communicated to Kœnig. But it turns out that the bee was right and the analyst wrong: for by solving the problem in another way I find that he erred by two minutes; and other mathematicians, with whom I have communicated, distinctly find the same thing, and we have also found how the error crept in.*

A. These angles must have been very nicely measured; for the difference of two minutes, or the 2000th part of the lesser angle, is very small indeed. How were the angles first ascertained?

B. Maraldi was a most accurate observer, and he gives the angles, as I have stated, 109° 28′ and 70° 32′; and he gives them to differ with the result of Kœnig's calculus, which was made after Maraldi had measured—so he could not have fancied the amount. But I have reduced it from measuring an angle to the easier operation of measuring a small line. If those are the angles, then it follows that the breadth of the rhomboid is exactly equal to the side of the hexagon, and you find it appears to be so. Also, if those are the angles, the rhomboidal plates are inclined to one another at the angle of 120°, that of the hexagon; and you find they do not differ when you place them together, one within the other. However, I admit that this is not a very close admeasurement of such small differences; and I presume Maraldi must have employed a micrometer. I have used one to compare the breadth of the plates and sides, and I certainly can find no inequality. At all events, the bee seems entitled to the benefit of Maraldi's previous measurement, which had been thought to put her in the wrong, now that the analyst and not she has been found in error. This, however, is nothing to what follows. A Berlin academician, thinking, I suppose, to do a kindness by Frederic II., objected to the bee, that though, if the dimensions of the cell be given, the saving is as I have stated, yet there is such a great waste of wax arising from those dimensions as proves the saving of wax to be no object. He sets himself the problem of what he calls a *minimum minimorum;* namely, to find the proportion between the length and breadth of the cell which saves most wax; and he finds it something quite wide of the actual proportions. Now, I went over this analysis, and again found the bee right, and the philosopher at fault; for he had wholly left out the hexagonal covering of the cell's mouth, which, whether for brood or honey, there always is; and I found the actual or bee's proportions to save more than the academician's, when this was taken into the calculation. I moreover found the sides to be so much thinner than the bottom. that a shallow and wide

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* See this fully explained in the experiments and demonstrations relating to the comb in this volume. There is some contradiction in Maraldi's statement, 'Mém. Acad. des Sciences,' 1712, pp. 310–312; but the above measure has always been considered to be that which he intended to *state as his result.*

cell would have cost more, even independent of
covering at the mouth. Again, he admits
form chosen to suit the bee's shape, which the f
he calls a true minimum never could; but I s
that it saves wax as well. Lastly, I have so
another problem of a like kind, namely, to find
angles that save most of the fine or difficult w
which is the angular or corner-working evide
and that also is the thickest part of the work
cessarily. I find the solution gives the very s
angles which the bee uses, and which also save
in the other view. So that she has hit upon
very form which in every respect is the most ad
tageous, and turns out to be on all grounds rig
as indeed we might well suppose when we recol
who is her Teacher.*

A. All this is most satisfactory, and it was w
stopping to state it. However, as we have ma
pause before our next advance, it may be jus
well to stop for a moment longer in order to c
sider what the bee's operation really is. How
should go to work had we to build cells is p
enough. Suppose we had discovered, which
should do by mathematical investigation, the p
per form, the due proportion of the width to
length, and the proper angles of the bottom
roof—then we should have drawings and pla
and by these we should either cut our planks, if

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* Lord Brougham has given in the original work (
sertations on Paley's Natural Theology, vol. i.) all the ma
matical demonstrations by which the positions in the
are shown to be undeniably true. He has also give
variety of curious observations and experiments on
architecture of bees, which appear to have escaped for
philosophers. This part of the work, as too abstruse
unavoidably omitted in the present publication.—Ed.

structure were of wood; or if it were of stone, which more resembles the bee's materials, and is, be it observed, much more difficult and complicated to work with, we should, by those plans and by models or frames, run our courses. It would be a nice and difficult work to make this masonry, and would require the builder, both in hewing the stones and in putting them up, to follow the details of the plan in its parts, and without any regard to the general figure or result. He would be wholly unable to succeed if he looked to that; all his building would be awry and out of the required figure; his only chance is to make his plan exact, and his model-frames suit it; and then he has instruments and tools, plumb-lines, squares and plumbs together, in order to raise his perpendiculars. By these he proceeds, for he cannot trust his eye or his hand a moment beyond the mere adjusting his work to his instrument and his plan. Now the bee confessedly has neither plan, except what is in her head; nor any model at all whereby to guide her hand; nor any instrument to adjust her work to the plan in her head; nor any tool to work with except her paw and her feeler, which is as her eye in doing the work. Then how does she work?

B. Certainly, this is a most important consideration. We cannot trust our eye or our hand an instant. We have no exact perception of the line, and no steadiness in pursuing it. We have recourse to plans and instruments because we cannot form our lines by volition, that is, by having a form in our mind and by making our hands follow that form. We therefore must first lay it down sensibly, and then guide our hands by material means. Thus we have no power of forming a dome, an arch, or a circle, or a perpendicular, or a level, or even a straight line at all, or any one line or form which we conceive in our mind. Far from being able to follow these lines in great works, as roofs and walls and excavations, we cannot even represent such forms on a sheet of paper by our handywork. If we could do this we should work like the insect, who acts immediately, and not through the instrumentality of means. Unable to execute any purpose of our minds, as she does, we have recourse to instruments. We endeavour, as far as we can, to reduce every thing to a physical or material process—to exclude mental operation or agency altogether—to make the whole a material, or as we call it, accurately enough, a mechanical operation. Reason no doubt has taught us to do so; but it has taught us a general rule; and there is little or no reason, little or no operation of the mind, in its application to the particular cases. On the contrary, the use of the rule or method is that it precludes the operation of the mind as much as possible, and makes the whole physical, or nearly so. To take an instance—we reduce, by engraving or printing, the whole operation of drawing a picture, or writing a page, to turning a lever, which does the work for us. So in building, though there is less mechanical facility, we guide our hand by the instruments employed and the lines drawn, making the operation as mechanical, as little mental, as possible. The bee's operation is all mind together. She has no plans, no instruments, no tools. It is as if by waving our hands among plastic materials we formed walls, and domes, and columns, and never deviated a hair's breadth from the perfectly accurate plan. I am very decidedly of opinion that this essential difference between the works of Reason and Instinct is of the greatest importance to our inquiry: for nothing can more show the peculiarity of the instinctive operation; or more prove that the mind of the agent is as it were the machine, and the instrument, to perform the work, and to perform it with an unerring certainty and with absolute perfection.

A. Does this, which appears to me, as it does to you, a most important consideration, bring us at all back towards the ground of Descartes, which we had passed over as forming a position wholly untenable: I mean, that the insect is a mere machine, fashioned by a perfectly skilful mechanic, and wound up to perform the functions which he designed?

B. Certainly not. The proposition which we have just been deducing from the facts is rather of a kind the very reverse: it affirms that the insect's mind performs the whole operation; it makes the insect's mind the machine, if I may so speak. But let us see to what it also leads or seems to lead us. We perceive there is mind at work, action exerted, effect produced; but we see that the mind is quite unconscious of the effect, and that the action works to a purpose which the mind never contemplated. There is a thing done, an important and rational thing done, but done by an agent who neither intends nor knows anything about it. Here there is design, but there is no designer—an action and an object no doubt; but that action performing. besides what the agent intended, knew, and did, something else (and that something the only important thing), which the agent neither knew nor intended, and cannot possibly be said to have done at all. This by no means leads us back cartes' position, but does it not lead u Isaac Newton's? The design is manif action is perfectly and surely adapted to purpose is with singular regularity effecte there not be a designer, and who can tha the Deity? There is none other that can gested even. Must it not be He?

A. Doubtless in one sense it must, as designer of all we see. But how is he designer here than he is of the motion heavenly bodies, or the growth and ge of plants?

B. As thus. In those cases there is but matter affected, or acting; whatever l originally imposed on matter are followe ever qualities first communicated to it played: all is material. There was desig original formation of it, in the prescribi laws, and impressing those qualities. Th these bodies fulfil; they conform to the and original intention of their being. Bu no renewed design, no repeated intention, and particular disposition in each case o The Deity made a stone, and made the that the stone falls to the ground by virtu general rule of their formation. He is referred to; he needs not interfere each support is withdrawn from the stone, in direct the path it shall take. If on that being withdrawn some interposition were to decide how it should go—for instance, it should stand still or not—although it mitted, that if it move it can but mov straight line downwards, the case wou resemble Instinct, though even here it would be different; for it is as if each hair's breadth of the stone's motion required a new action to carry it on in its course.

A. The Deity created matter so as to obey in each case certain general laws: so he created mind in like manner to obey certain laws in each case. Wherein do the two facts differ, the fact of material and the fact of mental action?

B. As thus. The moving power is wanting in the one case. The law is that matter shall act in a certain way, and mind in a certain way; but is it the mind of the insect that acts when the whole mental process is wanting, namely, the knowledge, thought, and will? Its mind acts, subject not only to a general law, but to a particular impulse each time. Who gives the impulse? Besides, your doctrine of the Deity creating the insect's mind such as to act so in given circumstances, applies quite as much to our Reason as to its Instinct. Let me, however, put a case: suppose we saw a man born blind, to our own knowledge, without any teaching, and without ever having tried it before, move his fingers in the design of giving them exercise, as to keep them warm, &c., but holding a pencil in them, and by the same act producing, unknown to himself, a beautiful and finished portrait, of perfect resemblance to the original: or suppose we saw a man who had been born and lived in a foreign country, and was utterly ignorant of our language, of which he had never heard a word, write a letter in correct English, or a beautiful copy of verses, while only meaning to try whether a pen was well cut, or the ink rightly made—these acts are quite analogous to the Instinct of bees. Nay, we may take a nearer case, and suppose a man who never had learnt ma thematics, and did not know a line from an angl to solve on a slate a problem of great difficult with perfect and unerring accuracy, and this whil he was only trying the pen and the slate; an suppose he then applied this solution to the com binations of a perfect time-keeper, while he thougl he was only cutting off the superfluous pieces two lumps of brass and steel of which he intende to make weights, he being wholly ignorant of wh a time-keeper meant. There is nothing mo strange in this than the bee's architecture. It indeed exactly, and in all its parts, a parallel i stance. In all such cases (the extra thing don and not known or intended, being far more difficu and more important than the thing intended a known to be done), we should at once pronoun that there was a miracle, because of the thing do being without the possibility of the apparent age doing it unassisted, according to the ordinary la of nature. In other words, want of power in t immediate agent compels us to believe in the inte position of another agent having the power. The is *dignus vindice nodus*, and we call in the *vinde* This is the foundation of all belief that there mu be supernatural agency where the laws of natu are suspended. But in the cases put there is n only want of power, but of design. If want of pow in the apparent agent drives us to suppose or inf the action of another unseen agent, want of inte tion or design should drive us to infer the inten ing of another designer, and want of both pow and intention should make us infer the thinking a planner who intends, and the action of an age *able to* perform the work; in other words, to inf the interference of one who has both the will and the power, each of which is wanting in the immediate or apparent agent.

A. In the case you put of a miracle, there is a single instance, and because it is solitary, we say the laws of nature are suspended, and we call in supernatural aid. In the case of Instinct, it is the constant course; it would be a suspension of the law, and a miracle, were it ever otherwise. It is as much part of the law of nature that the animal should do the thing in question without intending it, or knowing how he does it, nay, that he does it at all, as that man should do it knowingly and intentionally, or that the animal should knowingly and intentionally do those other things in which he acts rationally, and not instinctively. Therefore this case does not resemble a miracle.

B. The case of a miracle I did not put in this way or with this view at all. I do not say that the instinctive act of the animal, or of man when he acts merely from Instinct, as he does, though most rarely, are to be compared with miracles as being suspensions of natural law; but only that the same reason which makes us, when arguing from such suspension of natural laws, conclude that some power has interposed different from the powers acting under those laws, requires us, when arguing from the acts done by the animal without either design or power, to conclude that some agent has interposed of power sufficient, and some intending and designing being of will fitted, to do the acts in question. Suppose, to put again my first case with a variation, we saw a blind man draw a likeness as often as he stretched his fingers with a pencil in them, and every foreigner of a certain

class write good English verses as often as h
a pen, and every man of a particular desc
make excellent time-keepers as often as l
away the parings of the metal balls he was f
into weights—we should in every such insta
these general laws (as they could now be)
right to draw an inference of one and th
kind. What would that be? Manifestl
here the same thing was done without kno
or intention, which in the other class o
(those where reason and experience operate
done by means of knowledge, and with int
For the gist of the question and the whol
culty is this—that we have two classes of
the same act done in the one class knowin
intentionally, and in the other, without kno
or intention—and as in the vast majority of
taken together of all kinds of agents, we
no such thing—indeed, cannot form the
such a thing—as an act without power and
do it, or a thing resulting to all appearanc
intention, because in itself such a thing
should do if we intended a given thing, a
without any Being to intend, so we are con
to infer the power, that is, the knowledge
intender.

A. Indeed, it must be observed, that w
speak of a miracle we mean, and commo
mean, two things, not only the fact seen of t
of nature being suspended, but the inference
of some power interposing capable of susp
them, and therefore above them, and having
over them; and this inference arises from t
cessity under which we feel of accounting f
phenomenon observed by supposing an ad

in short, from our being unable to conceive
ng done without a cause. The ordinary
with which we are acquainted fail to ac-
for this event, and we therefore infer another
to be in operation.

Certainly it is so; but then this is precisely
e with Instinct, as compared with the other
nena, namely, those things done with both
dge and design on the part of the agent,
things in doing which the agent is known
nd intends, and knows what he does. Sup-
ccording to the case so well put by Paley, in
inning of his book,—suppose you find on a
n a watch going and producing manifestly
t according to its construction; this would
design in its maker; but only a former, or
, a spent and executed design. Nothing
be seen designing or intending, as it were,
your eyes. Suppose, then, you saw the
or other machine, making a second and
achine, but not by mechanical contrivance
hat, too, like the case put by Paley, would
ly be evidence of a former, or bygone, or
d design,—you must suppose a new watch
ade before your eyes without any material
, or, which is the same thing, made by a
e wholly incapable of performing the opera-
elf. Then you would necessarily infer from
he existence of some being, some thinking
igning and skilful being, capable of doing
u saw, that is, of making the machine; and
uld suppose this just as much if you saw
pable body performing the operation, as if
w the operation performed without any
or sensible material agent at all. Now,

this is precisely the case of the bee: i incapable body or being.

A. May it not all be said to be only inference of original and general design, a duce that conclusion from the structure of t of animals, and the functions suited to tha ture which those limbs perform?

B. Even if it were so, there is the br tinction between mere mental and mere agency; and the difference between the in to which those agencies respectively lead. apprehend the difference is greater still tl The two cases are not at all the same (hardly even analogous. We never know o or any combination of material parts, a affected but in one way. We have not mat and matter without, gravity, cohesion, im bility. But if the phenomana of instinct a regarded as only one class of mental phe we have here two kinds of mind, endo wholly different qualities, and acting in different ways; one kind such that the be sessed of it neither knows nor intends wh doing, and yet all the while does exactly both knew and intended. Nay, in one (agent possessing this mind is manifestly act; in the other, he is as clearly incom any way that we can conceive. If no bein concerned except the apparent, and unc and impotent agent, it is like matter gravi a centre which does not exist: and then, the thing still more incomprehensible, and ference between matter as subject to gene and this case the more extreme, both the *of mind* are found in the same individual sometimes uses, as it were, the one, sometimes the other; he sometimes acts knowingly and intentionally; sometimes blindly, as an instrument to do he knows not what, nor cares—as if we had a piece of matter, a lump of metal, for instance, which at one time was heavy, and at another flew about in the air.

A. There is certainly a material difference; and I should not much wonder if we were, sooner or later, driven by the extraordinary nature of the case to some new conclusion. These things have really not been sifted as they deserved. Men have rested satisfied with general and vague statements, and I suppose their attention has been too much engaged by the great curiosity of the facts connected with the subject to let them closely reason upon the theory. However, I must again recur to my supposition, and refuse to quit this position where we now stand until we have examined it more accurately. There are two kinds of mind, I will say. Then the Deity created two kinds originally. As he created two kinds of substance or existence, mind and matter, and as he endowed these with different qualities, so did he endow the two kinds of mind with different qualities. As he made matter solid and heavy, and made mind imperceptible to the senses, but endowed it with consciousness, so he gave the two kinds of mind different qualities—both of course must have consciousness, which I take to be the essence of all mind, at least we cannot conceive mind to exist without it—but one he made such that it could act rationally, knowing and intending all it did—the other such that it acted without knowing or intending. This hypothesis, you perceive, gets rid of the necessity of supposing

a constant interposition of the Deity, unl
sense in which He is said to interfere for
pose of maintaining and executing the ge
which he originally framed for the whole

B. I perceive no such thing. I do
your supposition at all meets the fact, or
the difficulty, or dispenses with the other
In one sense I may grant your assumption
if you only meant that the Deity origina
the animal should act in a certain way
pose which He fore-ordained, and whic
concealed from the animal itself, though fo
to Him, the Creator. But in the sam
rational acts and intentions may be said
been fore-known and fore-ordained by th
which indeed seems, at least in the case
telligent agent, only to mean that with t
there is no such thing as present and f
all things are seen as present. But the
solves itself into saying that the Deity
designed and ordered the animal's acts;
this is the same thing as if He actuall
intended and did each act of the anim
moment of action—which is the same t
saying that the Deity constantly acts and
animal, and that is the theory in question.
any other sense, to what does your objecti
hypothesis put by you in order to escape
clusion, amount? Only to this, that t
created the instinctive mind such that it a
out knowledge or intention, exactly as th
mind acts with both the one and the other.
theory of course never meant to deny
instinctive mind was created by the D
endowed with certain qualities. Sir Isaa

ssly excludes the supposition of the Deity the *anima mundi*, or the soul of any part of 'e, and clearly never intended to represent , as Himself the soul of animals, but only as tantly guiding that soul. But the theory ls that the mind being endowed with certain lities originally and at its creation, those lities are summed up in this one, namely, to , and to act *quasi* mind, but without knowledge design, and yet to produce all the effects of th, and, moreover, that this constitutes the whole the qualities of instinctive mind. This mind erefore was created such that it must always be e blind instrument in the Creator's hands; its iowledge and design, by the hypothesis, reside as were out of itself and in some other intelligent eing, that is, in the Deity, who is to supply at each istant, the knowledge and design wanting in the nimal mind, or to know and intend for it—and rhether the Deity performs this operation, exerises knowledge and intention, beforehand and once or all, or constantly and continually at all times, eems an immaterial distinction referable to the ormer head of the alternative. The question lways recurs—Was a mind created of such a pecies that it could act *quasi* mind without knowng and intending? Is not that contrary to the ature and essence of mind? Nay, is it not a conradiction in terms? And is not your whole iypothesis of two kinds of mind grounded on a alse position, which supposes a substratum to be ndowed with various qualities, and then, in order o make two kinds of that substratum, confounds he qualities with the essence? For what is mind ut that which thinks, knows, wills? If there be no knowledge, will, intention, at all, mind is concerned in the operation, and we come to Cartesian hypothesis, that the animal is a machi Therefore knowledge and design there must and it must either exist in the animal mind or some other mind which uses or employs the ani as an instrument. Can this higher mind do beforehand, or otherwise than by constant op tion, that is, constant exertion of itself?

A. Then are we not getting either to the D being the soul of the animal, or to the mind of animal having none of the qualities constitu mind?

B. We may suppose the mind to be the n power of giving voluntary motion to the limbs, to consist of no other quality, unless it thinks intends. Then the Deity may have suffered i have these powers, and to use them in some thi and there His own intelligence does not interfi but not to use such powers in other things, there His intelligence does interfere.

A. There *is* knowledge and intention in the mal. The bee, for instance, knows it is carry wax to a given place, and placing it in a gi direction. So far as the thing is done, the ag knows, and wills, and intends what it is doing, this in every possible case of instinctive action.

B. But the whole question arises, not u what the bee knows and intends, *e. g.*, putting ticles of wax in a place, but upon what she car possibly know anything about—the giving work a peculiar form, most difficult to discover first, most advantageous for a certain end, and more difficult to follow and work by even w *discovered*. The question always is, who desi and knows these things unknown to the bee? And we cannot conceive the Deity acting thus originally through a future and non-existing animal; although we can easily enough imagine Him acting through an existing animal at the time. This is supposable on the theory of essential ubiquity, or indeed upon any theory of ubiquity, even virtual. It merely requires ubiquity—whether of essence, or of power—some ubiquity—which no one denies who believes in a Deity at all.

A. A child shall place together different lines and angles, or other parts of figures, so as to form certain diagrams. The figures he thus unwittingly makes have certain properties quite unknown to him. All he intends or knows is to put the parts together; the rest is consequential, arising from the necessary relations of number and figure: so in cases of physical or contingent truth: he may do, and mean to do, and know that he is doing, what will form a certain combination; but the laws of nature acting on that combination, produce, unknown to him, effects which he never intended, and knew nothing of; as if he mixed sulphuric acid and oil of turpentine, and there was an explosion; or an acid and an alkali, and there was a neutral salt and a crystallization.

B. This, when examined, we shall find either to be a case wholly different from the one in question, or to be only *idem per idem*, as lawyers say when they have a case put which is like enough to the one in hand, but just as difficult to resolve; so, in either way, the argument will remain unaffected. If the child plays with the things at random, and they happen to fall into a certain shape once, or it may be twice, that is certainly not the case of the bee, which regularly, and without ever fai always makes the figure required; and, upon b obstructed in her operations, varies her mea she can again attain the particular form. I the other hand, the child places the things al accurately in the same way, then the case not resembles the one in question, but becomes iden with it; all the arguments and all the difficu apply; it is exactly *idem per idem*. So again, the child does a certain thing with knowledge a design to do that and no more, leaving the rest be done by some law of matter unknown to this is not the case of Instinct; for the bee doe that is done by the operation of mental age the wall, the hexagon, the rhomboid, are all by the bee's living power; she does not place and leave it to fall into hexagonal forms, as we salts and leave them to crystallize into cube hexagonal prisms; she forms the figures her and when she has done her work nothing rem to be done further by any law of nature. B the child makes a combination constantly and rectly, say some useful substance not to be by accident or random working, then the c comes the same, and the argument is not by it in any way.

A. You often complain of my obstinacy I call sometimes caution, and sometimes s according as I may be in a self-compla modest humour.

B. Then, as I do not remember ever seen you in the former state of mind, you must always call it slowness, whi else ever called it; but I will call it ca ask what more it leads to?

4. To this—that I would again hanker after
doctrine of general laws, primarily impressed
matter and mind both. You argue, and argue
ly, that the operations of matter and of mind
to be kept apart; you allow that the material
ration is explicable by and referable to general
s; you allow, too, that whatever is wrought by
operation of mind, acting as such, is explicable
and referable to general laws of mind, originally
osed, *e. g.*, to desire what is agreeable to it by
general constitution; to reject what is by the
e constitution disagreeable. But you say that
see, in the case of instinctive actions, operations
which desires and aversions will not account,
l operations carried on as if by the most refined
l correct reason, and yet without any material
physical interposition; that is, without any in-
umentality whatever, as if a cast were made
hout a mould, or a print without a plate.
om hence you say it is difficult to understand
w there should not be here an intelligent being,
well as mere desires connected with the senses—
ause connected with the understanding. Now,
nkering as before, I still ask—though perhaps,
er our long argumentation, with somewhat di-
nished confidence—may not this be accounted
by supposing a general law adapting and ad-
ting all the proportions beforehand? May not
Deity have originally appointed the taste or
ire of carrying caterpillars in the solitary wasp,
instance, exactly to the very number required
feed the worm after born, when, by the laws of
tter, the egg shall have been hatched and the
ub produced? So may not the bee form her
xagons *and her rhom*boids, in consequence of a

gratification felt by a fore-ordained law of her
nature, in following those lines and angles, and no
other?

B. That this is barely conceivable I may perhaps admit. But it is wholly unlike any oth
operation of the senses and desires of which we have
any knowledge. It means this, that each desire i
so nicely adjusted as to produce in the animal th
effects of reason and intention in man, or of reas
and intention in the same animal when acting wit
design and knowledge, and not instinctively. Th
bird is to have a pleasure in bringing sticks
moss to a certain place, just at a given time, a
putting them in one position—the solitary wasp,
bringing, and only in bringing, for it never tast
a certain number of caterpillars, and to have
gratification in bringing one more, but the strong
desire, because a sensible pleasure, in bringing t
eleventh as much as the first—also no kind
gratification in carrying the eleventh to any oth
place than the same where all the other ten we
put—also a like pleasure in forming the hole f
them, without the least regard to the use she is
make of it, nay, ignorant beforehand of its bei
to have any use; and yet all the pleasure of carr
ing caterpillars is to consist in carrying them
that particular hole, and there is no gratificati
to be derived from carrying them to a place o
hair's breadth on the right or the left. Still mo
—it means that the bee is to have such a gratific
tion as proves irresistible, and occupies her who
life, in tracing certain lines and angles; and y
this strong desire is so far under control, ev
of reason, that on obstacles being interposed, oth
lines and angles are to be made, reason suspendi

'e for the moment. So that the law ori-
imposed, and the quality impressed on the
as not one and inflexible, to do a certain
l circumstances, viz., to follow the impulse
esires implanted, and which form the ani-
ture; but it was a law or order coupled
ondition, and, as it were, giving a discre-
power provisionally, or a power to be used
n circumstances; it was as thus—a law or
do a certain thing, to obey the impulse of
re, unless certain events shall happen; and
d in that case to cease following the im-
the desire, and to follow another guide,
r to use a faculty, namely, reason, and act
g as it should direct, allow, or recommend
ircumstances. Now, in the mere union of
vith reason, while the desires act blindly
lse and the reason with discrimination,
nothing at all inconsistent or incompre-
; it is the ordinary case of all mental
ns. But the peculiarity of the case now
d is that the desires act exactly like reason,
ng the very same effects unknown to the
hich reason does with his knowledge. Are
then calling different things by the same
hen we say that it is the influence of de-
d appetites which makes the bee form her
the spider her web? Might not the same
argument be applied to the operations
d on all hands to be those of reason, for
, the investigations of Newton or La-
Might it not be said that they were in-
l by an irresistible propensity, from deriving
atification in drawing one line and using
isor rather than another? But we know

this not to be the fact. Why and how? from their statements and our own consci But for this, the same argument might b and no one could refute it. So in the cas animal we argue thus, because we cannot and learn how she works. The impulse (all along be borne in mind) of which the ar speaks is a physical one, *i. e.*, the effect external object, or, which is the same thin operation of the animal's body, on her se is a gratification of this specific kind wh explanation assumes—if not, it explains r Then how little resemblance does any such fication which we can form any idea of (the bee to her lines or angles, and the wasp to her carriages and deposits) bear t we know and feel to be the ordinary na physical gratification, and the desires co with it?

A. This consideration has much weight— the way you put the question as to the ma ticians. It seems to show that we have j same right, in the case of the animal's inst conclude in favour of design and reason, intelligent agent, and to conclude against it animal impulse or the direct operation of tl sical senses, as we should have, did we mathematicians at work, observe their proc mark the result congruous with that proc fore we spoke to them on the subject of ho working was conducted. Indeed it is rem that we are in point of fact just as much the evidence which the thus inquiring o would afford, as we are in the case of the a *for who* ever asked the question of either or Lagrange, and yet who doubts that both worked their problems from knowledge with intelligence? The reason why we do not ask them is, that we have no kind of doubt in our minds; the view of the operation is enough for us. This is because we say to ourselves, "If I did so and so, I know it would be from knowing and meaning to do so and so, and not from any physical gratification." This inference we transfer to others, by saying, "Therefore I believe they act in like manner."

B. Certainly; and this, observe well, is the foundation of all our reasoning as to design. The only argument we ever have or can have in favour of any intelligent cause, from seeing the adaptation of means to ends, on surveying the works of nature, is, that, if we had done so and so, we should have had the design. All we see is the fact of an adaptation; the inference of a cause, or of a designing being, rests on the kind of reasoning you have just stated. So that in reality we have reached this important position, that our argument for the existence of a designing cause at all in the universe rests on no better, indeed no other foundation than our argument that instinctive action proves an interposition of the Deity at each moment.

A. I must further observe, however, that beside the great weight of this consideration as last presented, I feel the difficulty of the hypothesis of an original law generally imposed to be much aggravated by the consideration you adverted to at the same time, of a provisional and conditional law—a law to operate or not, according to circumstances, as if two implements had been given to the animal, Instinct and Reason; for I feel the very gratuitous nature of this assumption; and I know that there is not a greater proof of our reasoning being merely hypothetical on any question than when we find ourselves obliged to mould, refit, and modify our hypothesis, in order that we may adapt it to the new observations of fact.

B. But there remains a difficulty still more insuperable in your way, which you do not yet advert to. The supposition of a law, and a provisional or conditional law, is all along founded on the assumption of a person to obey it, to act instinctively, unless a certain thing happens, and then to use Reason till a certain other thing happens, and then to fall back upon Instinct again. What can be more gratuitous, not to say absurd? The supposition that the Instinct is to cease and the Reason to begin in a certain event, implies that the animal acting by Instinct all the while was reasonable and intelligent, else how could he know when to lay down his Instinct and take up his Reason? If I send a man to go straight on till he meets a messenger, or sees a finger-post, he is just as much a rational agent all the while he does not deviate from the way, as he is when, meeting the messenger or seeing the guide-post, he does deviate. So that the theory involves here this absurdity, that the instinctive action is all the while an intelligent and rational operation, contrary to the supposition. I can really imagine nothing more decisive or demonstrative than this—and I purposely kept it to the last.

A. Perhaps the end is not yet come; you have said nothing of the known errors or mistakes of instinct—and thus I reserve also my strongest argument to the last. I own that it was this consideration which, always meeting me, drove me to deny the Newtonian doctrine, and to find any or every other escape from it; for surely if the Deity is always acting, there can be no mistake—every thing must be perfectly successful and quite certain. Yet how many cases of mistaken instinct do we see? Mules begotten; flies deceived by the smell of the stapelia to lay their eggs where they cannot breed the maggots, supposing the vegetable an animal substance putrefying; and many others. Now, if this was only the result of similar desires originally implanted, there is no difficulty; for the law would be to follow that smell, and this law is obeyed.

B. Now, I really think you have just yourself answered your strongest argument; for you admit there was that general law. Had it no design? Doubtless, and but one, to lead the animal towards its food, and the nest for its young—the two great objects of all nature, preserving the individual, and continuing the species. Yet here they fail in particular instances, and do neither. Then is not this a defect or imperfection in the general law, detracting, *pro tanto*, from its adaptation to work its undoubted purpose? The same Being gave the general law whom the Newtonian theory supposes to be the particular agent. Then is it not just as inconsistent with His perfections to believe He has made a faulty statute, as to suppose that He makes a mistake in particular cases? Can there be any difference at all here?

A. How do we get out of this in the general case?

B. You mean, how do we answer sceptical, or rather atheistical arguments, drawn from these supposed errors or imperfections? Only by saying, that as in the great majority of cases the design is perfect, and the wisdom complete, it is probable that further knowledge would remove all apparent anomalies, and reduce everything to order, and to a consistency with perfect wisdom and skill. In truth, we always assume design, even where we cannot trace it. The physiologist never supposes any part which he sees produced, as the spleen, to have no use; but rests satisfied that there is a purpose, though he has failed to discover it; and he hopes that it will hereafter be revealed to his inquiring eye. So when he finds apparent imperfection, he has a right—nay, it is sound logical reasoning—to suppose, that further knowledge would prove it to be perfect, as in the vast bulk of cases he has found perfection. The instances of erroneous or defective instinct are as mere nothing compared to those of true or perfect instinct.

A. We also approach here the argument on the Origin of Evil. There is something to be said, though perhaps not much, as to the irreverent nature of the supposition that the Deity acts, considering the meanness or impurity of some instinctive operations, and the trifling nature of others.

B. You may well say, not much in this; there is absolutely nothing at all. Our present argument only refers to physical, and not to moral considerations. Moral feelings or actions are of course not instinctive at all. There is no blame where there is no choice—no knowledge—no intention—no reason. Then, as to indifferent acts; there is nothing small, or mean, or impure in the Deity's eye. There is nothing in this more than is sometimes, *without* due consideration, urged against the doctrine of Essential Ubiquity. It all proceeds upon a forgetfulness that the Deity cares as much for one creature as another; all are alike proofs of his wisdom; all alike objects of his favour. So as to matter; there is nothing impure or disgusting, except in relation to our weak and imperfect senses, which are, for wise purposes, so formed as to delight in some things and to repudiate others. This is all relative, and relative to ourselves and our imperfect nature. To the Deity it can have no application. The structure and functions of the maggot, bred in the most filthy corruption that can disgust our senses, exhibits, even to the eye of the philosopher, how cumbered soever with the mortal coil, as marvellous a spectacle of Divine skill and benevolence as the sanguiferous or the nervous system of the human body, or the form of the most lovely and fragrant flower that blows.

A. I think the instinct of hunger has begun to operate upon my structure; whether stimulated by the operation of the gastric juice upon the coats of the stomach, or how otherwise, I do not stop to inquire. Nor do I apprehend that our good hostess's instinctive love of order and method would approve of our keeping dinner waiting.

B. Your own excellent mother was the pattern of that regularity, as of so many other admirable qualities; and the intercourse of society was in this, as in far more important particulars, greatly reformed by her example. Therefore let us adjourn our further discussion, of which not much remains, at least not much that is difficult, till to-morrow.

BOOK OR DIALOGUE III.

ANIMAL INTELLIGENCE.—(FACTS.)

A. IT must be confessed, that for a subject so extremely amusing as well as interesting in a higher view, Instinct has been giving us but little matter of entertainment. I question if any persons ever talked upon it for so many hours without almost a single anecdote, or illustration of any kind from the facts, which are inexhaustible in variety, and every hour present new matter of wonder. Indeed, those ordinarily known are full of interest; and we have been going on with, I think, two, the bee and the solitary wasp, never even casting a look over the rest of this boundless and variegated field.

B. Why truly so; and the reason is plain enough. We had a problem to solve, and we set ourselves to try our hand at it. We assumed that the whole facts resembled those few to which we applied our arguments, or from which we drew our inferences; and our choosing two was quite right and safe—indeed, one rather than two, for we have dwelt more on the solitary wasp than even the bee, because no question could ever be made in her case of training or traditionary instruction. I do not at all repent of having pursued this course; it has prevented digressions and distractions, which would have ensued, had we gone upon the facts at large. We should have been perplexed, sometimes by questions of evidence, sometimes by minute differences of no importance to the argument, sometimes by analogies only calculated to mislead. Our way has been to pitch upon a good example or two, which in some sort embody the subject, as far as matter of fact is concerned—an abstraction of Instinct, as it were, without immaterial particulars—and to confine our reasonings and our illustrations to that. However, there can be no sort of reason why we should not now reward ourselves with a little of the entertainment which, as you say, so amply belongs to this great subject.

A. The Instincts which we have been considering as our choice examples, especially that of the bee. are certainly the most wonderful of all the animal phenomena. But the cases where sagacity is shown, and which seem really quite inconsistent with the doctrine that denies brutes all rational faculties, are most frequently cited to raise men's wonder; and, as I take it, for this reason, that we set out with supposing the common animals to be wholly devoid of intelligence, and are astonished to find them sometimes acting as if they had it—while the operations of Instinct being in many brutes above what any degree of intellect can account for, we refer these to a totally different origin.

B. I quite agree with you. Perhaps one need not go much more now into examples of Instinct. None can exceed that of the bee, which has from the beginning of the creation been working, and all over the world working, in the same manner, upon the successful solution of a problem in the higher mathematics, which only the discovery of the differential calculus a century and a half ago could enable any one to solve without great difficulty at all; and which a celebrated mathematician, who was devoted to the ancient geometry, though an adept also in modern analysis, when he solved, conceived that he had gained no small victory for that favourite science by showing that it could solve this question of maxima and minima.

A. Nevertheless, there are other wonders of a like kind, those which show Instinct to be as great in manufactures as the honeycomb proves it to excel in architecture. The paper-making of the wasp is of this class. She makes a paper as excellent as any manufacturer at Maidstone; she has been for sixty centuries acquainted with what was only discovered by men between five and six centuries ago—for I think the question raised by Meerman confined the discovery to the years between 1270 and 1302, though afterwards a specimen was produced as early as 1243. Moreover, when some of the more recent improvements, as the lengthening and equalizing the fibres, are considered, it is found that the wasp was all along acquainted with these useful devices also.

B. I have observed, too, in examining her structures, that she makes two kinds of paper, white and brown, the former being fine cambric paper, and the two glued together by an excellent smooth and durable kind of cement. The white paper, I find, takes the ink as well as if it were sized.

A. When stories are told to excite wonder under *the head* of Instinct, they generally relate not to

Instinct, but to the Reason or Intelligence which animals show. However, there are other wonders of Instinct beside those we have been adverting to. The uniformity of the operations of animals of the same species everywhere and at all times is remarkable; and the expertness they show from the first clearly proves that instruction and experience has nothing at all to do with the matter. Bring up a crow under a hen or under any other bird, it makes as exact a crow's nest as if it were born and bred in a rookery.

B. So Maraldi found that a bee an hour old flew off to the proper flowers, and returned in a little time with two pellets of farina, then supposed to be the material for making wax, now known to be used only in making bees breed, since the capital discovery of our John Hunter showed wax to be, like honey, a secretion of the animal. Nay, before birth too the animal works to an end, and with the same exact uniformity. The inimitable observations of the great Réaumur show that the chick, in order to break the egg-shell, moves round, chipping with its bill-scale till it has cut off a segment from the shell. It always moves from right to left; and it always cuts off the segment from the big end. There is no such thing as a party of what Gulliver calls "little-endians" in nature. All these singular Instincts, however, regular and uniform though they be, are, when circumstances require it, interfered with by the rational process of adapting the means to the end, and varying those means where the end cannot otherwise be attained. But Instinct is regular and steady in all ordinary circumstances.

A. The vast extent of the works performed by animals, especially by insects, is no less won than their instinctive skill. This arises from immense numbers, and the singular Instinct w by they always work in concert when grega What can be more astonishing than the wo the termites, or white ants, which in a nigh undermine and eat out into hollow galle solid bed or table, leaving only the outside sh rind, and soon will make that too disappear!

B. Or the ant-hills in tropical countries, t and fifteen feet high, as if men were to m building the height of the Andes or Him Mountains, when they are vain of having ma little pyramids? But let us go to instances other class—of Intelligence.

A. Had we better begin this new discuss ascertaining whether or not the doctrine of cific difference between man and the lower a is well founded; or had we better begin wi facts?

B. I am upon the whole for beginning w facts; and I should come at once, as we ha been speaking of concerted operations of In to the case of the beaver, which is, under th of Intelligence, almost as wonderful as th ceedings of the bee and the ant are under Instinct.

A. But before quitting the bee, and the ar the wasp, let us just observe their rationa They are nearly as notable as their instinctiv The bee, upon being interrupted by Huber operations, shortened the length of her cells;

vient to the rational; and, in fine, adapted her building to the novel circumstances imposed upon her; making it, in relation to these, what it would have been in relation to the original circumstance if they had continued unaltered. It is found, too, that the ant, beside the wonderful works which she instinctively performs, has the cunning to keep aphides, which she nourishes for the sake of obtaining from them the honey-dew forming her favourite food, as men keep cows for their milk, or bees for their honey.

B. On this discovery of Huber some doubt has lately been thrown; and do not let us trouble ourselves with anything at all apocryphal when the great body of the text is so ample and so pure. But the expeditions of a predatory nature are by all admitted. They resemble some of the worst crimes of the human race; the ants undertake expeditions for the purpose of seizing and carrying off slaves, whom they afterwards hold in subjection to do their work—so that the least significant and the most important of all animals agree together in committing the greatest of crimes—slave-trading.

A. With this material difference, that the ant does not pharisaically pretend to religion and virtue, while we bring upon religion the shame of our crimes by our disgusting hypocrisy. But the wasp, too, shows no little sagacity as well as strength. Dr. Darwin relates an incident, to which he was an eye-witness, of a wasp having caught a fly almost of her own size; she cut off its head and tail, and tried to fly away with the body, but finding that, owing to a breeze then blowing, the fly's wings were an impediment to her own flight, and turned her round in the air, she came to the ground and cut off the fly's wings one after the other with her mouth. She then flew away with the body unmolested by the wind.*

B. I have myself observed many instances of similar fertility of resource in bees. But perhaps the old anecdote of the Jackdaw is as good as any—who, when he found his beak could not reach the water he wanted to drink, threw into the pitcher pebble after pebble till he raised the surface of the liquid to the level of his beak. Lord Bacon tells it of a Raven filling up the hollows in a tree where water had settled.

A. Or the Crows of whom Darwin speaks in the north of Ireland, who rise in the air with limpets and muscles, to let them fall on the rocks and break them, that they may come at the fish. It is said that animals never use tools, and Franklin has defined man a tool-making animal; but this is as nearly using tools as may be—at least, it shows the same fertility of resources, the using means towards an end.

B. It does a little more. It shows the highest reach of ingenuity, the using the simplest means to gain your end—the very peculiarity for which Franklin's own genius was so remarkable. He could make an experiment with less apparatus, and conduct his experimental inquiry to a discovery with more ordinary materials, than any other philosopher we ever saw. With an old key, a silk thread, some sealing-wax, and a sheet of paper, he discovered the identity of lightning and electricity. Here we are instituting a harmless comparison between the bird and the sage: but the crow's genius is said once to have come in collision with the head of a philosopher in a less agreeable manner, when, mistaking the bald skull of Anaxagoras for a rock, she let fall the oyster from such a height that it killed him.

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* Zoonomia, Sec. xvi. 16.

A. But there certainly must be allowed to be even nearer approaches to tool-making, or, at least, to the use of tools, among animals. There are many insects which use hollow places, and some which use hollow reeds or stalks for their habitations.

B. Indeed they do; and perhaps the most remarkable of all proofs of animal intelligence is to be found in the nymphæ of Water-Moths, which get into straws, and adjust the weight of their case so that it can always float—at least, Mr. Smellie says that when too heavy they add a piece of straw or wood, and when too light a bit of gravel.* If this be true, it is impossible to deny great intelligence to this insect.

A. Why should we doubt it? The crow in rising and letting the muscle fall shows as great knowledge of gravitation as the moth in this case.

B. But an old Monkey at Exeter Change, having lost its teeth, used, when nuts were given him, to take a stone in his paw and break them with it. This was a thing seen forty years ago by all who frequented Exeter Change, and Darwin relates it in his Zoonomia. But I must say that he would have shown himself to be more of a philosopher had he asked the showman how the monkey learned this expedient. It is very possible he may have been taught it, as apes have oftentimes been taught human habits. Buffon, the great adversary of brute intelligence, allows that he had known an Ape who dressed himself in clothes to which he had become habituated, and slept in a bed, pulling up the sheets and blankets to cover him before going to sleep; and he mentions another which sat at table, drank wine out of a glass, used a knife and fork, and wiped them on a table-napkin. All these things, of course, were the consequence of training, and showed no more sagacity than the feats of dancing-dogs and bears, or of the learned pig—unless it were proved that the ape on being taught these manipulations became sensible of their convenience, and voluntarily, and by preference, practised them—a position which no experiments appear to support. Smellie, however, mentions a Cat which, being confined in a room, in order to get out and meet its mate of the other sex, learnt of itself to open the latch of a door; and I knew a Pony in the stable here, that used both to open the latch of the stable, and raise the lid of the corn-chest—things which must have been learnt by himself, from his own observation, for no one is likely to have taught them to him. Nay, it was only the other day that I observed one of the Horses taken in here to grass, in a field through which the avenue runs, open one of the wickets by pressing down the upright bar of the latch, and open it exactly as you or I do.

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* Transactions of Royal Society of Edinburgh, vol. i., p. 42.

A. I have known, as most people living in the country have, similar instances, and especially in dogs.

B. But there is one instance of animals catching their prey in a way still more like the tool-making animal. I do not allude merely to the Spider's web, or to the Pelican's use of his large open pouch in fishing; but to an American bird, of which you find a curious account in the *Philadelphia Trans-*

*ctions.** It is called the *neun-tödter* by the Ger- nans, as we should say the *nine-killer*, and is found o catch grasshoppers and spear them when dead pon twigs where the small birds come on which t feeds; for the grasshoppers themselves it never ouches. These are left, generally about nine in umber (from whence its name), the whole winter, nd they attract the birds of which the animal in uestion makes its prey. This is really using one reature as a bait, in order thereby to decoy and atch another.

A. It is certainly a singular and curious in- tance, whether of Instinct or Intelligence. Are here not stories told of apes using a cat or some ther animal—I should suppose rather anything han a cat—to get chesnuts out of the fire?—or what else is the origin of the phrase *cat's paw?*

B. Fable, I presume. Many fables have a real rigin in fact: this, I suspect, has not. Monkeys, n the contrary, have been used by men to obtain ruit or cocoa-nuts, by pelting them, and their efending themselves with a fire of nuts.

A. That, however, is a plain instance of sagacity nd imitation. They used missiles, as missiles were sed against them. Some of our own belligerent neasures of retaliation have not always been nearly o judiciously contrived.

B. No: we once, by way of retaliating on Na- oleon, helped him; as if the monkeys had pelted hemselves, instead of throwing at us. However, n unexceptionable authority, Captain Cook, or at east Captain King, in Cook's last voyage, has a ingular instance of sagacity in the use of means, nd almost weapons, in Bears. Here you have his account of their mode of hunting: "The wild deer (*barein*) are far too swift for those lumbering sportsmen; so the bear perceives them at a distance by the scent; and, as they herd in low grounds, when he approaches them, he gets upon the adjoining eminence, from whence he rolls down pieces of rock; nor does he quit his ambush, and pursue, until he finds that some have been maimed."*

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* Vol. iv.

A. Certainly, such a well-attested fact as this is very important, and worth a thousand stories of lions and jackals. But you spoke of coming at once to the Beaver, as the parallel to the Bee.

B. Certainly it is, and may be called, in respect of its works, the Bee of quadrupeds, or if you will, of Intelligent animals, holding among them as high a place as does the Bee among Instinctive creatures. Nevertheless, there may be some doubt raised how far Instinct has a share in his operations. They are of great uniformity: all packs or companies of beavers, and at all times, build the same shaped structure, and resemble one another closely in matters which are arbitrary, and therefore cannot be considered as the result of experience or reflection—cannot be dictated by circumstances. This, however, opens a question of some difficulty, which, according to the plan we are pursuing, may be left to the end of our discussion, after we shall have gone through the facts. In considering the beaver, I think we shall do well to follow Buffon, as we did upon the ape, because he purposely rejected everything marvellous or doubtful in the accounts he had received from travellers, and these must have been numerous, for Canada was then a French colony. Those singular animals assemble in bodies of from two to four hundred, and choose a convenient station in the lake or the river, having regard to the slope of its banks and their woodiness, but also, no doubt, to the frequency of floods in the water. If it is a lakè, or a river that varies little in its level, they build their huts without any further structure, but if the level changes much, they construct a dam or dyke, what we call a breakwater, extending eighty or a hundred feet across, and ten or twelve broad: they thus keep the water nearly of the same height, at least they thus always obtain a sufficient depth of water. They then work in concert on the wood, gnawing the trees and branches to suit their operations. A tree the thickness of a man's body they will soon bring down by gnawing round its base, but on one side merely, and they know so exactly the operation of gravity on it, that they make it fall always across the stream, so as to require no land-carriage. It must be observed, in passing, that if they do this the first time they have built, and without any previous experience of falling bodies, the operation must be taken as purely instinctive. They form their cabins so as to contain from fifteen to twenty-five or thirty animals; each cabin has two doors, one to the land, and one to the water, in order that they may either go ashore, or bathe or swim, and sit in the water, which is part of their pleasure, or rather of their amphibious existence. They have in each cabin also a storehouse for placing the parts of the shoots on which they feed (for that they make provision against winter is quite certain), and room enough for accommodating their young when brought forth. The cabins are built on piles, so as to be out of the water;

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* Cook's Third Voyage, vol. iii., p. 306.

they are neatly plastered with cement, the a flat and scaly tail being used as a trowel operation. They are of sufficient strength t not only the stream and floods to which occas they may be exposed, but also severe sto wind. The beavers choose to work with a k earth not soluble in water, and which th with clay. Such is the account of thos rational and intelligent proceedings which I sceptical beyond all men of stories respecting reason, sifted out of all he had heard, after re everything that bore the appearance of exa tion or fancy. He adds, that a single beaver he had, showed, in its solitary and domestic no signs of sagacity or resources; but rath peared to be a stupid animal. According strange theory, that animals are degenerat mind, and losing their faculties as man im (a notion derived from confounding their dominion, power, and numbers, in a wild with their loss of intellect),* he consider beaver as the "only subsisting monument ancient intelligence of brutes."

A. They say doubts have of late been cast the former accounts of the beaver. I am Hearne, one of the best North American trav is cited for this.

B. Here is what that excellent observer upon the subject: you shall judge if he has least altered the case. The beavers select, he either in small lakes or in rivers, spots whe water is of such depths as not to freeze t bottom, preferring, however, running water cause this helps them to convey the timber

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* Vol. iv., p. 73, and v., p. 21.

quire. They begin by forming a dyke across
ith fascines, stones, and mud, but without piles
uried in the ground; this dyke, whose only use is
give them a convenient level of water, is convex
n the upper side fronting the stream; and it be-
omes solid and strong by repeated repairs, so that
he branches sprout, and birds build in the hedge
hich it forms. Each hut contains commonly one
r two, but sometimes four families; and some-
imes each is separated from the others by a parti-
ion. The hut has a door opening on the water,
nd no connexion with the land. He then goes on
o show how they cut down and build, wherein he
iffers from the common accounts only in saying
hat no piles are used in the construction. They
work, he says, only by night, and each season they
over the buildings with a new coat of mud-plaster,
s soon as the frost sets in. In summer they make excursions in the woods, choosing the trees they mean to make use of, and marking the position of new settlements, when their increase of numbers requires them to plant colonies. Their wood-cutting begins at the end of summer, and the building is carried on in autumn. They have also subterraneous retreats along the banks of the river or lake, to serve as a place of refuge when they may be attacked by the glutton. You perceive, then, that there is very little discrepancy between this account and Buffon's; indeed, there is one remarkable addition to the latter, if it can be relied upon, the precaution taken in summer to choose and to mark out the convenient stations where the new settlements are afterwards to be made.

A. There seems reason to suppose that other animals still preserve their sagacity and act in concert. No one can have observed a flock without perceiving that they have senti to give the alarm. Indeed, wilder birds manner. Fieldfares, when they are o tree which you approach, remain steady less until one at the extremity rises or and gives a loud and very peculiar note when they all get up and fly, except on tinues till you get near, as if she rema that there really was occasion for the and to call them back if the alarm pro one. She too at length flies off rep alarm-note.

B. In the forests of Tartary and of S rica, where the Wild Horse is gregariou herds of five hundred or six hundred, wh ill prepared for fighting, or indeed for any and knowing that their safety is in flight, sleep, appoint one in rotation who acts a while the rest are asleep. If a man appr sentinel walks towards him as if to reconn whether he may be deterred from comin the man continues, he neighs aloud and in tone, which rouses the herd and all ga the sentinel bringing up the rear. N be more judicious or rational than this arr simple as it is. So a horse, belonging gler at Dover, used to be laden with run sent on the road unattended to reach t vous. When he descried a soldier he w off the highway and hide himself in a when discovered would fight for his l cunning of Foxes is proverbial; but I k it was ever more remarkably displayed t *Duke of* Beaufort's country; where Reyn

d pressed, disappeared suddenly, and was, after
ct search, found immersed in a water-pool up to
very snout, by which he held a willow-bough
ıging over the pond. The cunning of a Dog,
ich Serjeant Wilde tells me of, as known to him,
at least equal. He used to be tied up as a pre-
ıtion against hunting sheep. At night he slipped
head out of the collar, and returning before
wn, put on the collar again, in order to conceal
nocturnal excursion. Nobody has more fami-
rity with various animals (beside his great know-
ge of his own species) than my excellent, learned,
l ingenious friend, the Serjeant; and he pos-
ses many curious ones himself. His anecdote of
lrover's dog is striking, as he gave it me, when
happened, near this place, to meet a drove. The
n had brought seventeen out of twenty oxen from
eld, leaving the remaining three there mixed with
ther herd. He then said to the dog "Go, fetch
m;" and he went and singled out those very
ee. The Serjeant's brother, however, a highly
pectable man, lately Sheriff of London, has a
g that distinguishes Saturday night, from the
ctice of tying him up for the Sunday, which he
ikes. He will escape on Saturday night and re-
n on Monday morning. The Serjeant himself
a gander which was at a distance from the goose,
hearing her make an extraordinary noise, ran
k and put his head into the cage—then brought
k all the goslings one by one and put them into
vith the mother, whose separation from her
od had occasioned her clamour. He then re-
ıed to the place whence her cries had called
. I must however add, that I often have con-
ed with Scotch shepherds coming up from the

Border country to our great fairs, and h them deny many of the stories of the r feats of sheep-dogs. Alfred Montgome the other day, cross-questioned a Roxl shepherd with this result.

A. Many of the feats which we are n ing to intellectual faculties may be i operations. How shall we distinguish?

B. The rule seems simple. Where done in ordinary and natural circumstanc be called instinctive or not, according as our reason could, in the like circumstanc us to perform or not, and according as t is in a situation which enables him to ingly or not. Thus a bee's cell is made ture untaught; a solitary wasp provide an offspring it never can see, and knows We set these things down to Instinct. fearing danger, appoint a sentinel, it r stinct certainly, but there is here nothing Intelligence, for they do a thing which well do by design, and so differ from the are aware of the object in view, and mea it, and so differ from the wasp. But the apply to acts done in ordinary circumst which I admit may or may not be i Another class is clearly rather to be calle I mean where the means are varied, ad adjusted to a varying object, or where t acts in artificial circumstances in any example, the horse opening a stable-door room-door, the daw filling a pitcher w So there is a singular story told by Dup mours in Autun's *Animaux Célèbres*, he says he witnessed himself. A Sw

ed its foot into the noose of a cord attached to
out in the Collége des Quatre Nations at Paris,
by, endeavouring to escape had drawn the knot
it. Its strength being exhausted in vain attempts
fly, it uttered piteous cries, which assembled a
t flock of other swallows from the large basin
ween the Tuilleries and Pont Neuf. They
med to crowd and consult together for a little
ile, and then one of them darted at the string
l struck at it with his beak as he flew past; and
ers following in quick succession did the same,
iking at the same part, till after continuing this
nbined operation for half an hour, they suc-
ded in severing the cord and freeing their com-
nion. They all continued flocking and hovering
night; only, instead of the tumult and agitation
which they had been at their first assembling,
y were chattering as if without any anxiety at
but conscious of having succeeded.

4. The means taken to escape from danger, and
provide for security, are certainly often of this
cription, the danger being often of a kind purely
idental and solitary, and the operation of the
mal varying in different and new circumstances.
ne birds wholly change their mode of building
avoid snakes, hanging their nests to the end of
nches, and making the exit in the bottom, in
ces where those reptiles abound.

5. So too the Ants in Siam make no nests on the
und, as with us, but on trees, that country being
ch subject to inundations. But you find this
nge of habits in animals, upon circumstances
nging, pretty general. The Dogs which the
niards left in the island of Juan Fernandez
e found to have lost the habit of barking, when

Juan and D'Ulloa visited that famous spot i course of their journey in South America. Po they found that barking warned their prey, enabled it to escape. But Dogs in Guinea and do not bark, and when European dog taken there they lose their bark in three or generations. This fact, then, is somewhat vocal.

A. The docility of some animals may, how as it seems to me, be strictly ranged withi class of facts we are speaking of. Although dren, as well as animals, learn through fear kindness, both operating (and fear alone suffice), yet it is an act of Intelligence to f the dictates of both feelings: it implies this cess of reasoning,—"If I do so and so, I have such a punishment or such a reward." the degree to which animals are teachable is derful. All Singing-Birds probably learn whole notes.

B. Yes; Daines Barrington has demons this by numerous experiments* on various b the young untaught birds, being placed i nests of different species of birds, always ha song of those it nestled with; and we all kno a Piping Bullfinch can be taught almost any They seem to have no notion of harmony o lody. I recollect a Green Linnet, which when a boy, or rather a mongrel between tha a goldfinch, being placed in a kitchen, and le its own fine and sweet notes, to take to an i tion, and a very good and exceedingly disco one, of a jack which, being ill-constructed, rally squeaked as if it wanted oiling.

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* Phil. Trans., 1776.

A. Dogs show the greatest talents in learning. he feats of pointers, but still more of shepherds' gs, after making all the deductions you have entioned, are astonishing. It almost seems as if e shepherd could communicate, by sign or by eech, his meaning, when he desires to have a rticular thing done. But assuredly the dog takes s precautions exactly as he ought, to prevent e sheep from scattering, and to bring back runays. Indeed, Greyhounds and other dogs of ace, as well as Pointers backing one another, ow the adaptation of, and variation in, the means ed towards an end.

B. Retrievers exceed all other dogs in this re-ect. There was one died here a year or two ago at could be left to watch game, till the keeper ent to a given place, and she would then join him fter he had ranged the field; nay, could be sent a spot where game had been left, and where she ad not been before. Indeed, she did many other hings which I have hardly courage to relate.

A. How were her pups? I have always found uch extraordinary faculties hereditary.

B. My worthy, intelligent, and lamented friend, . A. Knight (so long President of the Horticulural Society), has proved very clearly that the aculties of animals are hereditary to such a point s this. He shows that even their acquired facul-ies—the expertness they gain by teaching—de-cends in the race. His paper is exceedingly cu-ious. But I think we need hardly go so far as to is minute details for proof of the fact. It is ound that where man has not been, no animals are ild and run away from his approach. When ougainville went to the Falkland Islands (or, as

the French call them, the Malouines), he
himself and his men immediately surrounded
kinds of beasts and birds; the latter settli
their shoulders. No navigators had ever been
before. Lord Monboddo says that the same
had been related to him by navigators.* It
clear, then, that the running away from
which seems natural to all wild animals in o
dering upon inhabited countries, is an ac
propensity, transmitted to the descendants of
whose experience first taught it them as nec
for their safety.

A. Have you Knight's paper here? I kn
accuracy of his observation to equal his gre
genuity.

B. To that I too can bear my testimony.
is his principal paper; read lately before the
Society. It is given as the result of his ob
tions and experiments, made for a period o
years; it is therefore most justly entitled to
respect. He chiefly dwells on the case of S
ing Spaniels, and among other instances giv
which is indeed very remarkable. He fou
young and untaught ones as skilful as the ol
not only in finding and raising the woodcock
in knowing the exact degree of frost whic
drive those birds to springs and rills of u
water. He gives the instance, too, of a yo
triever, bred from a clever and thoroughly-
parent; which, being taken out at ten mont
with hardly any instruction at all, behaved
and knowingly as the best-taught spaniel, i
ing into the water for game that was shot,
pointed out to it, however small, bringing

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* Origin of Language, b. ii., ch. 2.

depositing it, and then going again, and when none remained, seeking the sportsman and keeping by him. He imported some Norwegian ponies, mares, and had a breed from them. It was found that the produce "had no mouth," as the trainers say; and it was impossible to give it them; but they were otherwise perfectly docile. Now in Norway, draught horses, as I know, having travelled there and driven them, are all trained to go by the voice, and have no mouth.—Again, he observed that they could not be kept between hedges, but walked deliberately through them—there being, he supposes, none in the country from which their dams came.

A. Does he speak of any other animal?

B. Yes, he mentions his observation on Woodcocks, which he could remember having been far less wild half a century ago; for on its first arrival in autumn, it was tame, and chuckled about if disturbed, making but a very short flight, whereas now, and for many years past, it is very wild, running in silence and flying far. He gives an instance of sagacity in a Dog, unconnected with hereditary intelligence. He one day had gone out with his gun and a servant, but no dog. Seeing a cock, he sent the servant, who brought this spaniel. A month afterwards he again sent for the same dog from the same place. The servant was bringing him, when at twenty yards from the house the spaniel left him, and ran away to the spot, though it was above a mile distant. This he often repeated, and always with the same result; as if the animal knew what he was wanted for. Leonard Edmunds tells me of a dog (a Newfoundland spaniel) of Mr. Morritt's, at Rokeby, which has been known to take the shorter road to where he

knew he was wanted, and leave the serva
keeper to go round about. You yourself tol
of a dog that met you sporting by a short c
known to you.

A. The manner in which animals can find
way is very extraordinary. But though, in
cases, it may be through close observation
observation the clearer and better remember
cause, like the Indian woodsmen, they have
ideas; yet, in other cases, it seems an Instinc
difficult to conceive in its workings. In tru
the stories told be true, I question if any in
we have yet examined of Instinct be so trul
accountable on any principles of intelligenc
have known of dogs sent to a distance, and co
home immediately, though taken in the dark.

B. That might be from smell or track,
stories are also told of dogs and cats taken in
pers, and finding their way back speedily. L
munds had one that was carried from Ambl
to three miles on the other side of Burton,
tance of twenty-seven miles, in a close hampe
a coach; and it found its way back next mor
Dr. Beattie's account of a dog which was ca
in a basket thirty miles' distance, through a co
he never had seen, and returned home in a
is less singular than this, even if it were as
authenticated. Dr. Hancock, in his excellent
on Instinct, which, however, contains fully as
upon the peculiar tenets of the Society of Fr
as upon our subject, relates the story of a
being conveyed from Scotland to London b
and finding his way back; of a Sheep retu
from Yorkshire to Annandale, a distance
least eighty miles; and of another Sheep retu

om Perthshire to the neighbourhood of Edin-
rgh. Kirby and Spence, too, in their *Introduc-*
n to Entomology, state, on the authority of a
ptain in the Navy, a strange anecdote of an Ass
ken from Gibraltar to Cape de Gat on board of
ip, and finding its way immediately back through
ain to the garrison, a distance of two hundred
les of very difficult country. The ass had swam
shore when the ship was stranded. This fact
ems to be well authenticated, for all the names
e given, and the dates.

A. There is no end of such facts, and many of
em seem sufficiently vouched. The *Letters on*
stinct mention a cat which had been taken to the
est Indies, and on the ship returning to the Port
London she found her way through the city to
ompton, whence she had been brought.

B. That is a work I have often wished to see,
d never been able to get. Dr. Hancock quotes
for one of the most remarkable proofs of sagacity
d resource in the Goat, and this operation has
en, it seems, observed more than once. When
o Goats meet on a ledge bordering upon a pre-
pice, and find there is no room either to pass each
her, or to return, after a pause, as if for reflec-
on, one crouches down and the other walks gently
er his back, when each continues his perilous
urney along the narrow path.

A. In Rees's Cyclopædia a story is given as
ell vouched, of a cat that had been brought up
amity with a bird, and being one day observed
seize suddenly hold of the latter, which hap-
ned to be perched out of its cage, on examining,
was found that a stray cat had got into the room,
d that this alarming step was a manœuvre to

save the bird till the intruder should depart. But what do you make of carrier-pigeons? The facts are perhaps not well ascertained; there being a good deal of mystery and other quackery about the training of them.

B. I desired one of the trainers (they are Spitalfields weavers generally) to come, that I might examine him about his art, but he has never been with me. I have read and considered a report made to me on the subject. It is said the bird begins his flight by making circles, which increase more and more in diameter as he rises; and that he thus pilots himself towards his ground. But still this indicates an extraordinary power of observation; for they come from Brussels to London and return. Nay, they have been known to fly from the Rhine to Paris. Serjeant Wilde took pigeons of the Rock kind to Hounslow, and they flew back to Guildford-street in an hour. They were taken in a bag, and could see or smell nothing by the way. On being let loose, they made two or three wide circles, and then flew straight to their dovecot. The Serjeant also knew of a cat which a shopkeeper's apprentice in Fore-street had been desired to hang, and found he could not. He then took it in a bag to Blackfriars Bridge and threw it into the river—the cat was at home in Fore-street as soon as the apprentice. He might have made a circuit, but certainly the cat returned in an hour or two. The grocer's name was Gardner—the distance is certainly above a mile, and through the most crowded part of London. The case of bees is referable to Instinct clearly. Honey-finders in America trace their nests by catching two bees, *carrying* them to a distance, and letting them fly.

Each takes the straight line towards the nest or ive, and by noting these two lines, and finding here they intersect each other, the hive is found. Now the bee is known to have a very confined phere of vision, from the extremely convex form f her eye. She is supposed only to see a yard or o before her.

A. I fancy we must pass over the subject of igration for a like reason. It seems still involved n much obscurity and doubt, though I take for ranted that no one now yields to Daines Barringon's theory, which denies it altogether.

B. Clearly no one; the facts are quite indisutable as far as negativing that goes; and indeed is reasonings are so full of prejudice, or preconeived opinion, and his suppositions for disposing f the facts so strained, that his argument never ould have had much weight. One fact seems also ot to be disputed, and is referable to Instinct lone. I mean the agitation which, without any ause, comes on upon a bird of any of the migraory classes at the appointed season of migration. t is, in all probability, connected with the sexual mpulses.

A. The communication with each other, which nimals have by sounds or signs, can, I think, ardly be doubted.

B. The observations of Huber clearly show that nts have a kind of language by means of their eelers or antennæ; and every day's experience eems to show this in other animals.

A. Some believe that they have a notion of what en, are saying, and no doubt very strange and ucky guesses have sometimes been made, one of hich I wrote you an account of. I had it from a most accurate and literal person, and it tends to prove that his shooting dogs had found out his intention of going into Nottinghamshire the day after. However, it is perfectly clear that these things are referable to minute and exact observation of things which escape us in the greater multitude of our ideas and concerns. All this, however, only illustrates the more how well animals can profit by experience, and draw correct inferences from things observed by them.

B. Among other instances referable plainly to intelligence must be ranked the devices which one animal is known to fall upon for benefiting by another's operations. The ant enslaving workers is the most curious instance certainly. But the cuckoo laying in other birds' nests, and leaving her progeny to be brought up by them, is another. Nor can this be set down wholly to the score of Instinct; for there are abundant proofs of her also building when she cannot find a nest, and then she lays in her own, and hatches and rears her brood. This curious and important fact, long disbelieved by vulgar prejudice, was known to that great observer Aristotle, who says she sometimes builds among rocks, and on heights.* Darwin confirms this by the observations of two intelligent friends whom he cites.† The man-of-war bird is a still more singular instance of contrivance, for though its food is fish, it has not such a form as to be fit for catching any, and therefore it lives piratically on the prey made by other fishing birds; hence the name we have given it.

A. Only think of our never having all this while said a word, or more than a word, of either the

* Lib. vi., c. 1.

† Zoonomia, vol. xvi., p. 13.

Fox or the Elephant, proverbially the two wisest of animals. Of the former's cunning every day shows instances; but that the elephant should be left to take care of a child unable to walk, and should let it crawl as far as his own chain, and then gently lift it with his trunk and replace it in safety, seems really an extraordinary effect of both intelligence and care, and shows that fine animal's gentle nature, of which so many anecdotes are told by travellers in the East.

B. The amiable qualities of brutes are not quite within the scope of our discussion, unless indeed in so far as whatever things are lovely may also be said to betoken wisdom, or at least reflection. The natural love of their offspring I should hardly cite in proof of this, because it seems rather an instinctive feeling. But the attachments formed between animals of different classes, a cat and a horse, a dog and a man, and often between two elderly birds, may be cited as interesting. One of these friends has been known to be unable to survive the other. I have heard this of two old parrots, upon the best authority.

A. We have said nothing of fishes, or of any marine animals.

B. Why, of these our knowledge is necessarily very limited. That they have remarkable Instincts, some of them resembling those of land animals, is certain. The Sepia, or cuttle-fish, ejecting a black or dark-brown fluid to facilitate his escape, resembles the stratagem of some beasts emitting an intolerable effluvia in the face of their pursuers. The Whale, when attacked by the Sword-fish, diving to such a depth that his enemy cannot sustain the pressure of the water, is another well-known example of defensive action. I used t serve with interest the wary cunning of th Carp in the ponds here: there was no decc them with bait, which the younger and less e rienced fish took at once. So little have men merly undervalued the faculties of fishes, Plutarch wrote an ingenious treatise in the for a dialogue, on the question whether land or v animals have the most understanding.

A. How does he treat this odd question?

B. Here is his book; and certainly as far a first portion of the subject goes, where the m of land animals are concerned, he sails befor wind. To his first remark I willingly subsc that those hold the most stupid doctrine upon subject (*οἱ αβελτερως λεγοντες*) who say that mals do not really fear, rejoice, remember, &c., but only do something like fearing, rejoi &c. (*ὡσανεῖ φοβεισϑαι*, &c.); and he asks what reasoners would think were it also contended animals do not see, but make as if they saw; hear, but make as if they heard; nor roar, make as if they roared; and, finally, do not but only did something like living. He the lates a great variety of facts respecting the saga of animals, some of them evidently fabulou the love of a dragon for a young woman), some, as the account of the ant laying in gr now proved to be erroneous; but he gives ot worthy of attending to. Thus, the contrivanc African crows, who, when the water was sca threw pebbles into deep cracks of the earth, s to bring the fluid up towards the surface, and wi their reach—the similar cunning of a dog on b of a vessel—the like device fallen upon by eleph to rescue one that had fallen into a pit—the astuteness of the fox, used by the Thracians as a kind of guide in crossing a river frozen over, to find out whether the ice is thick enough, which the animal does by stopping and listening to hear if the water is running near the surface—the judicious mode of flight in which cranes and other birds of passage marshal themselves, forming a wedge-like body, with the strongest birds at the front angle or point. But when he comes to the other side of the question, and is to state the case for the fishes, we find a great falling off both in his facts and in his evidence. Beside telling very absurd stories about crocodiles in Egypt obeying the call of the priests and submitting to their influence, he dwells upon the Sepia, whose escape in a black cloud of his own making he compares to the tactics of Homer's gods; upon the cunning shown by fishes in gnawing lines to escape with the hook; nay, upon a story he tells of their helping one another to escape when caught, which is plainly groundless; upon the Torpedo, or electrical eel, giving shocks, which is clearly a mere physical quality, and no more indicates reason than the shark using his teeth; upon shoals of fishes, like flocks of birds, forming themselves into wedges when they move from one sea to another, which is certainly true; upon the dolphin loving music, which is purely fabulous, as well as the feats of wisdom and philanthropy that he ascribes to this fish (*μονος γαρ ἀνϑρωπον ασπαζεται καϑο ἀνϑρωπος εστι*); finally, upon all the fables to be found in the poets respecting this fish. After reciting one of these, by way of proving his case in favour of marine animals, he innocently enough says that although he had promised to relate no fables, he now finds himself, he knows not how, in the company of Cæranus and Ulysses, and so he brings his notable argument to a close.

A. How does he ultimately decide the question propounded?

B. With a verse of Sophocles, intimating that both sides have gained some advantage towards a common purpose; but the victory is given to neither, the umpire pronouncing that both the arguments combined overthrow the doctrine of those who deny Reason and Intelligence to animals generally.

A. There are no modern books which fully discuss this subject systematically, either as regards Instinct or Intelligence. One is exceedingly disappointed in consulting our best writers, whether metaphysicians or naturalists, with this view; and the omission is the less to be excused because there are great opportunities of observing and comparing: this branch of knowledge is eminently suited to inductive reasoning; we live as it were among the facts, and have not only constant facilities for making our experiments, but are in some sort under a constant necessity of doing so.

B. Truly it is as you say. I have often felt this disappointment and this disapprobation. The works of metaphysical writers contain a few scattered suggestions, or dogmas, and with these they leave the subject. Naturalists, who could throw so much light upon it, confine themselves chiefly to the structure and functions of the organs, and leave the mental part of the subject out of view. Yet a physiologist, who also applied himself to this latter branch of the inquiry, would be the person best qualified to grapple with its difficulties and to throw light upon it. Therefore I learnt with extreme satisfaction that an able and learned professor of Natural History had given a course of lectures upon it at Paris, and was still more gratified to find that he soon afterwards published them. I speak of M. Virey's work; those two thick volumes lying there contain above a thousand pages on the Habits and Instinct of Animals; and to raise my expectation still higher, it professes by its title to deal in facts—for it is called *Histoire des Mœurs et de l'Instinct des Animaux.*

A. Well; I suppose you rushed upon it to slake your thirst?

B. As a traveller upon a delicious and copious spring, and found it a picture; or upon a luscious-looking large peach, and found my mouth filled with chalk. I have had these volumes here these two years, and I can barely now say I have been able to get through them. They are throughout not only written in the very worst style of French sentimental declamation, but they avoid all precision, all details, all facts, as something grovelling, common-place, and unimportant. The constant object is not to find out or illustrate some truth, to describe or arrange some phenomenon, but to say something pretty, far-fetched, and figurative. And all this with an arrangement of the classes of animals so methodical, that on looking at the contents, and finding they proceed regularly from the structure of the globe and the general qualities of its different products, to mammalia, then to birds, reptiles, fishes, and so downwards through the invertebrated animals, ending with zoophytes and mollusca, you naturally expect under each head to have what the title promises, a History of the

Habits and Instincts; and find nothing of the kind from beginning to end, but only trope after trope, one piece of finery after another, nothing but vague declamation long drawn out, an endless succession of the most frivolous sentimentality. Truly such a work, from so learned a naturalist, one who could so well have instructed and entertained us, had he but chosen to be plain and didactic, instead of being brilliant and rhetorical, where all eloquence and ornament are absolutely misplaced, is no small offence in the literary world.

A. I'll assure you our French neighbours are not the only sinners in this particular. I have been somewhat mortified of late years at perceiving a tendency to fine writing and declamation among our own men of science, and I ascribe it, in some degree, to the more general diffusion of scientific knowledge, which naturally introduces the more popular style of composition. Our Society of Useful Knowledge has no sins of this sort on its conscience, because we correct with unsparing severity all we publish; but you may perceive the tendency of popular explication to run in this bad direction, from the kind of matter that is often submitted to us for revision. I am sure I sometimes draw my pen through half a page of fine writing at a time.

B. I will engage for it you do inexorably whenever you find such outrages. My experience is precisely the same; and I am just as severe on those parts, evidently the prime favourites of the learned and very able writers. But we originally set out with firmly resolving to be most rigorous in matters of taste, being aware, as you say, of the tendencies of popular writers. In truth, however *that vile* florid style darkens instead of illustrating and while we never can write too clearly to the people, we never can write too simply, if our design be to write plainly and intelligibly. But though our Society is free from having any of this blame, I cannot quite acquit of all blame the meetings, however useful and praiseworthy in other respects, of an association which brings crowds of hundreds and thousands together, to hear mathematicians and chemists making declamatory speeches. I must say that those assemblages offer some violence to Science, at least they somewhat lower her by showing her cultivators trying a trade they no more can, or even ought to excel in, than poets in solving questions of fluxions. It is since these meetings, otherwise useful and excellent, rose into eloquence, that I have seen a mathematical discussion, by a very able and learned man, in two consecutive pages of which I reckoned up above twenty metaphors—all tending to darken the subject—to say nothing of poetical quotations without any mercy. Formerly declamations were reckoned so little an accomplishment of scientific men, that when Bishop Horsley filled our Royal Society with a factious controversy, the ministerial side, Sir Joseph Banks's party, had to send for assistance—and where think you they went for an orator?

A. I suppose to some Nisi Prius advocate.

B. Guess again.—No!—So humble were their views of oratory that they went to the other side of the hall, as the lawyers say, and got for their champion, Mr. Anguish, who was Accountant-General, a Chancery man, and had perhaps made as few speeches as any one in that Court. But in the work which I have referred to, and even in those scientific meetings, there is at least much that is highly valuable, much good grain, and the trash may be rejected as chaff—whereas, in this piece of French declamation all is chaff, and hardly a grain can be gleaned out of the light and worthless matter.

A. Can you find nothing by sifting and bolting it? I generally find something even in the worst books.

B. I will not say that these heavy volumes of light matter contain absolutely nothing; but wondrous little assuredly they have to reward the pains of searching. What can be more hateful than a man of science unable to speak of granivorous animals without terming them Pythagoreans and Gymnosophists; calling the crying baboon of South America a wild Demosthenes, the lion a generous prince, the jackal a courtier; describing the nightingale as appealing to Heaven against the robber of her nest, and the crocodiles as the "sad orphans of nature," because hatched in the sand; nay, carrying his ridiculous fancies into actual practice, seriously explaining the mild temper of one animal by the sweetness of its humours, and the ferocity of another by the acrid juices of its system—all a pure fiction in fact, as well as a gross absurdity in theory! Then mark the consistency of a philosopher—a consistency worthy of the veriest mob. He denounces, as the most atrocious of men, the experimenter on a living dog or rabbit, Fontana, or Majendie, I suppose, and afterwards speaks with the utmost composure of dividing a bee in two, in order to examine her honey-bag. Of the bee, indeed, he seems very moderately informed. He speaks of Aristarchus having devoted his life to the study of this insect, instead of *Aristom*achus; assumes to be true the notion long exploded of honey being collected from flowers, instead of a secretion in the stomach; will not believe that wax, too, is a secretion, though he refers unconsciously to Huber's experiment of obtaining it from bees feeding upon sugar and water; and, to set off his modern natural history with a little false classical lore, must needs call the cells "their citadel, or the palladium of their republic."

A. Bad enough in all conscience. But now give us the grain or two of wheat in all this bushel of chaff.

B. First, and this makes it more provoking, the author writes clearly and admirably when he chooses to leave off declaiming. There is a long note upon vertebrated and invertebrated animals, showing with much clearness and precision that in the former, which have a cerebral and nervous system, Intelligence prevails; in the latter, Instinct. He maintains the specific difference of Instinct and Reason or Intelligence with great force and clearness; indeed, there seems nothing to find fault with in his statements here, except that he places the seat of Intelligence in the cerebral nervous system, and of Instinct in the ganglionic, and thus is forced to deny Intelligence altogether to insects, whereas we have seen that Huber's observations plainly show the bee to have the capacity of varying its means in accomplishing the end in view when the circumstances vary; and this surely cannot be distinguished from Intelligence. Also he discusses, with perfect strictness of reasoning, the hypothesis of a very celebrated naturalist, no less than M. Lamarck, and, I must say, refutes very satisfactorily the theory of my most learned and worthy colleague, for whom we all must feel the

most profound respect. He had been i
suppose that Instinct results from the hal
nally acquired by animals adapted to th
stances in which they found themselves
the beginning of the creation, and that th
occasioned an adaptation of their structu
ticular operations, as well as a constan
and desire to perform them. Now, my
jection to M. Virey's refutation of thi
which is merely the exploded doctrine
tencies in a new form, is, that it require
elaborate answer to overthrow it. For
we see in all nature which in the least e
to suppose any animal at any period to
the power of altering his bodily struc
ating one part and altering another acc
his wants? Besides, if animals, at their
ation, had so much power and so much in
as this theory supposes, why should this
and leave them only possessed of blind
now? The reasoning, however, of M.
sound, and does much credit to his acuten

A. But have you found, in his vol
facts; nothing to place among the pl
which we are collecting previous to resu
discussion respecting the faculties of brut

B. Very little; and that so wrapped
clamation, and so disfigured with figures
thus speak), that there is no small dif
seizing hold of it. What he says of t
tecture of squirrels, marmots, rats, and s
rodents, is new to me. I had only been
the beaver, among this tribe, as remarkab
genuity. But it seems these others excel a
in digging subterranean dwellings; they m

partments or chambers, which they line with clay, and cover with a roof from the weather; in some of these chambers they stow vegetables, which they previously dry in the sun; others they use for the reception of their young; in others they sleep. He brings together some curious instances of swift and long-sustained flights of birds. Thus the smallest bird, he says, can fly several leagues in an hour; the hawk goes commonly at the rate of a league in four minutes, or above forty miles an hour. A falcon of Henry II. was flown from Fontainebleau, and found, by its ring, at Malta next day. One, sent from the Canaries to Andalusia, returned to Teneriffe in sixteen hours, a distance of nearly seven hundred miles, which it must have gone at the average rate of twenty-four miles an hour. Gulls go seven hundred miles out to sea and return daily; and Frigate-birds have been found at twelve hundred miles from any land. Upon their migration he states, as a known fact, that Cranes go and return at the same date, without the least regard to the state of the weather, which shows, no doubt, if true, a most peculiar instinct; but these, and, indeed, all facts which we find stated by a writer so addicted to painting and colouring, must be received with a degree of suspicion, for which no one but M. Virey is to be blamed. The accounts, however, of the swiftness of birds, I can well credit, from an experiment which I made when travelling on a railway. While going at the rate of thirty miles an hour, I let fly a bee; it made its circles as usual, and surrounded us easily. Now, if there was no current of air or draught to bear it along, this indicated a rate of ninety miles an hour; and even allowing for a current, the swiftness must have been great. I should, however, v peat this experiment before being quite great a swiftness in so small an insect.

A. Have you given all your gleaning work?

B. I should, perhaps, add these two. in it a curious passage from an old Spanis the seventeenth century, giving a quaint account of the sagacity of the beggar Rome; and we also find the titles of som works on the faculties of brutes, whic curious, and show how great a degree o that laborious people have paid to th but, at the same time, betray not a li characteristic boldness and enthusiasm speculations.

A. I conclude you have never seen these titles in this book?

B. Never; and I really should wish works themselves. One is *Mayer de pœnis Brutorum*, 1686, in quarto. A 1725, *Hermanson de peccatis Brutor* however, is printed at Upsal. A third is *de Simulacris virtutum in Brutis An* 1691; and a fourth, *Schrœder de Bruto gione*, 1702. Then, it appears that one wrote, in 1672, a *Dissertation on the Animals*, and Meyer and Martin, not done, followed this up a few years afte with a *Treatise on the Logic of Animal* other with one *De Animalium Syllogisn*

A. Does the Spaniard give any curio lars of dogs?

B. Not perhaps any that surpass wha been stating from facts known among ut his account is diverting enough. "The blind-an's dog," says he, "will take him to the places here he may best hope to get his alms, and bring im thither through the crowd by the shortest way nd the safest; nay, he will take him out of the ity some miles to the great church of St. Paul, as ou go to Ostia. When in the town he cometh to place where several ways meet, and with the harpness of ear that the blind have, guided by ome sound of a fountain, he gives the string a erk by either hand, straightway will the poor dog urn and guide him to the very church where he nows his master would beg. In the street, too, noweth he the charitably-disposed houses that be herein, and will lead thither the beggar-man, who, topping at one, saith his pater-noster; then down ieth the dog till he hear the last word of the eadsman, when straight he riseth and away to anther house. I have seen myself, to my great joy, ningled with admiration, when a piece of money vas thrown down from some window, the dog vould run and pick it up and fetch it to the naster's hat; nor, when bread is flung down, will e touch it be he ever so hungry, but bring it to is master, and wait till he may have his share iven him. A friend of mine was wont to come o my dwelling with a great mastiff, which he left y the door on entering; but he, seeing that his naster had entered after drawing the string of the ell, would needs do likewise, and so made those ithin open the door, as though some one should ave rung thereat."

A. Upon my word, you have been amusing ourself with making the old Castilian speak in ld English.—But now, I think, we may be said to have gone at sufficient length into the facts, and to have gathered together a collection large enough for our purposes of speculation—nor have we perhaps much more to do with this in that way. For can any one rationally doubt that they evince in these brutes some faculties at least approaching in kind to our own—nay, and to such of our own as we are wont to prize the most, and to be the proudest of? No blind impulse of a mechanical kind, no mere instinct, or feeling, or operative principle, apart from knowledge, experience, learning, even intention,—can surely account for the things we have just been considering as done by animals—and one example, and an ordinary one, is as good as a thousand. The cat opening a door from observing men do so before it; or the bird, from its own observation of the effect produced by solid bodies, sunk in water, raising the water by throwing in pebbles; or letting muscles fall to break the shells—these things surely argue a thinking and a reasoning process.

B. There seems little doubt of this; however, we may perhaps adjourn the further discussion, as we no longer require to be among our books, but may take our walk out in the sun, which is far from disagreeably hot to-day.

A. I have no kind of objection, and will meet you on the Terrace as soon as I have written my letters.

BOOK OR DIALOGUE IV.

ANIMAL INTELLIGENCE.—(THEORY.)

accordingly finished our letters, and prepared o out and walk about in the sunny exposure, :h a north-west wind made agreeable, as in the h it often does, even at this season—" calceis estimentis sumptis, placitum est ut in aprico ime patente loco conveniremus:*"—where, as valked about, he began in continuation of his remark.

.. I know not why so much unwillingness ld be shown by some excellent philosophers to v intelligent faculties, and a share of reason, to lower animals, as if our own superiority was not e sufficiently established, to leave all question alousy out of view, by the immeasurably higher e which we occupy in the scale of being, even ld we admit the difference to be in degree er than in kind; because when the difference of ee becomes so vast, there is hardly any more ıce of encroachment or confusion, hardly any e likeness or comparison, than if the difference ; radical and in kind. Some writers, as D. vart, really seem to treat the question as one of xciting nature, and almost to regard the purity

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Having taken our boots and greatcoats, we chose to meet ı open and sunny exposure."—Cic. De Repub. lib. i. , 12.

of religious belief as involved in the controversy. How is this, and why should it be?

B. It is possible that the origin of the feelings shown by those good and able men, resembles that of Descartes' absurd theory, of brutes being like machines, which, as far as he holds it, he avows to have proceeded from the notion that unless they are so, their souls would be immortal. But another reason may be assigned. The sceptical, or free-thinking, philosophers always lowered human nature as much as possible. They regarded it as something gained to their arguments against religious belief, if they could show the difference to be slighter than is supposed between men and brutes; and that there is a chain of being from the plant, nay almost from inorganic matter, up to man. They seem to have had a confused idea that this helped them even to account for the constitution of the universe, "without the hypothesis of a Deity," as Laplace is said to have termed it when Napoleon questioned him on the remarkable omission in the 'Mécanique Céleste.' Thus much is certain in point of fact, that those philosophers, and especially the French school, were fond of lowering the human intellect by raising that of animals; and while the priests were lavish of their admission that our moral nature is utterly corrupt but claimed for our intellectual capacity to be only a little lower than the angels, the society of the Encyclopédie, and the coterie of Baron d'Holbach were fond of levelling the intellectual distinction between immortal and confessedly mortal beings, though they denied the moral depravity of their race with perhaps no very strict regard either to *the evidence* of their consciousness or of their

rvation. It thus appears that this theory of a
rence in kind is found in company with that of
ticism, just as some other theories are usually
pled with it also; for example, the selfish
em,—philosophical necessity,—expediency,—
erialism,—all of which are held by Hume,
ltaire, Helvetius, Diderot, and other free-
kers; yet all of which are also held by some
letermined believers as any that are to be found
any church. Priestley, for instance, held all
se doctrines, and Paley all but the last. Hume's
nion on the reason of brutes cannot be doubted
m some accidental remarks interspersed in his
itings. Helvetius, a materialist and sceptic both,
explicitly stated that if the arm of man had
nced to terminate in the foot of a horse, he
uld still have been found wandering about as
tenant of the woods.* The company in which
opinion has been found has thus greatly dis-
lined pious men towards it. Professor Robinson,
his attacks on the French school, is nowhere
re severe upon them than where he impeaches
m of endeavouring to lower the dignity of
nan nature,† and undoubtedly such attempts
y be made in a manner to hurt the interests
h of religion and of morals.

A. Has not Lord Monboddo given great offence
he same kind, and in the same quarters?

B. Possibly he has; although from his station as
dge, and a man of most loyal political opinions,
l also from his being an orthodox believer, at
st as far as professions go, he has been less blamed
n the rest. He was an admirable Grecian, such
in modern times Scotland has very rarely pro-

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* De l'Esprit.

† Proofs of a Conspiracy.

duced; and there is an infinite deal of ingenuity and subtlety as well as learning in his writings, with a constant display of most correct taste in judging of the ancient controversies. But his theory has subjected him to great ridicule, not so much from his holding that there is a gradation in the whole scale of beings, and that the mental faculties of man are found in the minds of brutes, as from his denying any specific difference even in body; and holding that originally men were fashioned like monkeys, and lived like them wild and savage.

A. I could much more readily understand this doctrine giving offence and scandal as heterodox, than the other; for it seems not very easily reconcilable either to our religion or indeed to almost any other received among civilized nations.

B. I consider it a thing just as little supported by the facts, as it is repugnant to all known systems of theology. But my objection to it is really not founded upon its tendency to lower human nature. On the contrary, I doubt if it does not rather exalt our faculties beyond all the ordinary doctrines, and draw a broader line of distinction between us and the lower animals than that which it was intended to efface. For surely if we have not only by our intelligence made the great progress from a rude to a refined state—from the New Zealander to Laplace, and Newton, and Lagrange—but have also, by the help of the same faculties, made the progress from the state of monkeys and baboons, while all other animals are the same from one generation to another, and have made not a single step for sixty centuries, and never have attempted in a single instance to store up for after-times the experience of a former age, our faculties must needs be immeasurably superior to theirs. In short, the only question is as to the nature of the difference.

A. I can well suppose a difference merely in degree sufficient to explain any diversity of condition or result. We have only to compare individual men together to perceive this. It is admitted that reason, nay, that the power of forming abstract ideas, as well as drawing inferences from premises, is possessed by persons whom yet you shall in vain attempt to teach the simplest mathematical demonstration. Then their faculties only differ in degree from those by which Pascal learnt geometry without a master or a book, and Newton discovered Fluxions, and Lagrange and Euler the Calculus of Variations. It may truly be said, that there is no difference in kind which could make a greater diversity in the result.

B. It may indeed be truly so said; but it may also be added, that there is not a greater difference, call it in kind or in degree, between the person whose obtuseness you have supposed, and a sagacious retriever, or a clever ape, than between the great mathematicians you have named, and that same person. Locke, whose calmness of understanding was equal to his sagacity, and never allowed his judgment to be warped by prejudice, or carried away by fancy and feelings, seems to have held this opinion, and indeed to have allowed some reason to animals. "There are some brutes," he observes, "that seem to have as much knowledge and reason as some that are called men;" and he goes on to say that there is such a connexion between the animal and the vegetable kingdom, as makes the difference scarcely perceptible between the lowest of the one and the highest of the other.

A. You quoted Addison's paper upon Instinct yesterday, in proof of his taking the Newtonian view of the subject. What does he say as to the Reason, and generally the Intelligent faculties, of animals?

B. He is, as you are aware, no very great reasoner; insomuch, indeed, that I have known persons made converts to Deism, or rather from Christianity, by reading his most feeble treatise on the Evidences. One man of great virtue, learning, and ability confessed as much to me. Accordingly, he is very wavering and inconsistent on this subject also, and encounters it with prejudice. At one place he says, reason cannot be the cause of brutes acting as they do; and then, after seeming to deny it, he only adds a kind of admission that they have reason: "for," says he, "were animals endued with it to as great a degree as man," &c. And again, in the same paper, he seems to deny it altogether. "One would wonder to hear," he says, "sceptical men disputing for the reason of animals, and telling us it is only our pride and prejudices that will not allow them the use of that faculty." This is exactly the notion to which I was a little while ago imputing the unwillingness of so many reasoners to allow brutes their fair share of intelligence. You see Addison considers it the natural course of a sceptic; yet surely Locke was as firm a believer as himself, and certainly a far more reflecting and intelligent one.

A. Perhaps we had as well consider, before going into the question, by what kind of logic the

ment is to be conducted, by what sort of evi-
ce we are to try the cause.

. I presume there can be no doubt here. We
t examine it according to the rules of inductive
nce. The facts are before us. Some we gather
n observation—those relating to animals ; some,
hose respecting the nature of the human mind,
ascertain by our own consciousness, or at least
fly by that, though in some sort also by ob-
ing other men's conduct, and communicating
n them ; but having no means of communicat-
with animals, we are reduced to our observa-
merely ; and then we naturally draw the in-
nce that, because the same things done by our-
es would be known by us to be done from
ain mental powers, therefore we ascribe those
ers to the animals. This conclusion as to our-
es is certain, because we know and feel it to be
by our own consciousness. With respect to
nals it is not nearly so certain, because we can-
either enter into their minds, as we do into our
, or communicate with them, as we do with
fellow-men. Nevertheless, by varying our ob-
ations on them, by making experiments on
ir faculties, by placing them in new and arbi-
y combinations of circumstances, we can reduce
chances of error to a very small amount, and
der our inferences as highly probable as most
he propositions of contingent truth are.

A. It is not, however, necessary that we should
go into an investigation of the nature of the
nan faculties. Our researches are in their na-
e comparative only.

B. Certainly ; and therefore, agreeing with you,
ould begin by laying down this position, that

all we have to do is to grant or to deny the
ence of certain mental faculties, and to as
the meaning of the terms which we employ
pressing these. Whatever those faculties n
in us, all we are now to consider is, whether
the brutes have the same, or in any degree.

A. I think it quite right and really fc
safety, in conducting the inquiry, to lay d
second preliminary principle or caution, n
that we have no right to argue from the
effects produced by certain endowments, or b
given combination or modification of these.
when we see what has been achieved by ma
contemplate the extraordinary monuments
by his industry, his activity, and his intelli
and the power which he has acquired ov
operations of nature, and of all other animal
fiting so largely by both, and when we co
this with the feeble state of those animals
having no accumulation of either knowled
possessions, and gained nothing upon man
man, we are drawing a contrast which really
nothing; because it is just as easily account
by supposing the two classes extremely diffe
degree, as by assuming that they differ in th
of their faculties. Thus to take a common ins
and one which Adam Smith himself gives as
ing a great difference between us and the b
they have no appearance of barter; but if
arises from comparing ideas together, and fo
a conclusion from the premises, and if, from
facts, animals appear to possess that power,
being no positive barter only shows that their
ment or reasoning faculties are weaker than
or that for some other reason, it is immater

the argument what, they have not acquired that particular result of the reasoning faculty.

B. I entirely agree in this general position, holding that the neglect of it has been one main cause of the errors into which philosophers have fallen on this question; I must, however, doubt the correctness of the position, that the brutes are wholly ignorant of barter. No one, as Smith says, ever saw one dog barter a bone with another. But many of the operations of both dogs and horses in dividing their labour, and of insects, as ants, in helping each other, seem referable to a principle not to be easily distinguished from barter. The division of labour is clearly to be observed among them. Of course I do not mean that comminute division by which bees work together, and in which they incalculably excel ourselves; for that we have classed as instinctive and unintentional, and therefore it cannot enter into our present argument. But horses plainly help one another in drawing, and take different parts of the work; so do dogs in the chace. However, to leave no doubt about it, and allowing beavers to act instinctively, the wild horses sleeping and watching by turns is a clear and unequivocal instance of the division of labour. But I admit your position—that if anything which is the result of a faculty, proved already to be one of the animal mind, is not possessed by them, this is no argument against their having that faculty. It may lead us to be the more cautious in examining the proofs by which their possession of the faculty is established: but that is all. Indeed, such distinctions are taken upon no more philosophical ground than he would have for his classification who should make two divisions of metals or of water, one the solid, and another the fluid, accordingly as they had different temperatures.

A. I hold it to be a part of the same preliminary position, that if brutes are shown to possess any given simple faculties, their not having the power of doing things only to be accomplished by combinations of these simple powers, does not impeach the proposition, already established, of their having those simple powers. For it would only show that they have not the combination, though they may have the separate powers. Does any other proposition occur to you as convenient to be laid down in the outset?

B. I should say this, which is perhaps rather a corollary from the last, that we must carefully distinguish between simple and composite faculties, as they are called. Indeed, I deny the accuracy of this form of speech, and I believe it tends much to error in metaphysical speculations. No system of psychology, ancient or modern, sanctions it; neither those of Hartley, Priestley, Berkeley, nor that of Reid and Stewart and Brown, although I think it has been much encouraged by the speculations of these last, and their separate treatment of our mental powers under distinct heads, how necessary soever this was for the elucidation of the subject. The mind being one, and entire, and invariable, without parts or composition, acts always as one being. It recollects, praises, judges, abstracts, imagines; and when you say that it exercises a compound, or complex, or composite faculty, as for example, the imagination, you only mean that it first exerts one faculty, then another, and then a third. We never should call the process by which chemists bleach vegetable substances a composite operation, because they first make oxymuriatic gas, then mix lime with water, then, by agitation of the water exposed to the gas, cause lime to combine, and then expose the vegetable fibre to this compound liquor; we say that these are so many successive operations performed, and not one complex operation. And so imagination is not one compound faculty, nor is imagining one complex operation of the mind. But that mind in succession remembers, abstracts, judges or compares ideas, and reasons or compares judgments—and the whole four successive operations form imagination; to which you may add the further operation of taste, which, rejecting one and selecting other results of imagination, produces the fruits of refined or purified fancy; if indeed this taste itself be anything but a sound exercise of judgment—a judgment refined by experience, that is, by constant attention to what is pleasing, and what disagreeable. The rapidity with which all these separate operations are performed by the mind, neither prevents them from being in succession and separately performed, nor at all shows the mind to have composition or parts. Giving names to certain combinations, or rather successions of operations, and not to others, may be correct; but it must be admitted is somewhat capricious. We talk of imagination as if it were one operation, though it is many; and yet we give no separate name to several other successions as rapid of our mental operations. So as to our moral feelings. We speak of conscience as one; yet it is, as Smith describes it, a succession (he says a compound) of several, among which pity for the party injured, and fear of the consequences to ourselves, are the chief. Yet we give no name to the reflection on past enjoyments, which is quick a succession of several emotions,—nam recollection, comparison of the present, and sorr ing for the contrast. However, as regards our sent purpose, the simplest part of the proposi is, that any given simple faculty or single operat of the mind being found to be possessed by anim the circumstance of their not possessing the co pound exclusively, or several combined, or a cessive operation of different faculties, is no pr against their having the simple ones. Thus, if t have no fancy, it is no proof that they have memory or judgment; because they may have th without having abstraction, which is one of faculties that go to make the imaginative proc But it is also no proof of their being without straction, and all the other simple or single fac ties; for it only proves that they have not power of using these faculties together, or rat in quick succession, and for the same joint purp And should they have the simple or single, with having the compound faculties or processes, would again argue no specific difference, but rat a diversity of degree.

A. I think these preliminary positions not o have cleared the ground for us, but helped u good way on our journey. There appears har much more to reason about now. The subject been a good deal enveloped in mist and smoke, fr confusion of ideas, and from prejudice and h feeling. These being blown away, it seems pre clear what the structure is that we are to exami

B. Before going to the brute faculties, let just cast a glance over the faculties which h been enumerated as belonging to ourselves, see if they should not be a little simplified—Sensation, Perception, Consciousness, Memory, Abstraction, Imagination, Judgment, Reasoning, to which have been added Taste and the Moral Sense; and Mr. Stewart thinks these not enough, adding among others, the power of connecting general or abstract signs with the things signified. Now suppose we admit the correctness of calling a state of mind in which it is purely passive an active power or faculty, as Sensation, which is merely the effect produced upon the mind by the operation of the senses, and involves nothing like an exertion of the mind itself, any more than receiving a hurt or a gratification passively is any exertion of the body, although the operation whereby that reaches the mind may be termed bodily exertion; then it will follow, and not otherwise, that Sensation is a faculty. But Perception is no doubt an active exertion of the mind. *Memory* differs from Recollection as Sensation does from Perception. The state of mind in which one idea calls up another, or a present state of mind influenced by a past state, is Memory. The exertion by which the mind voluntarily induces the present state from the past, is Recollection. The one is the *sensation*, the other the *perception* of the past, as sensation and perception are of the present.

A. Is not Perception an inference from Sensation? I have the sensation of solidity or of smell, and I perceive either the solid, resisting body, and the odorous body, or I perceive the solid or odorous quality, that is, I infer a being from the sensation, or I infer a quality; the former seems a simple inference, the latter an inference coupled with an abstraction.

B. I do not incline altogether to this opinion; but at any rate it will not apply to Memory and Recollection; for Recollection is not an inference from Memory; it is an effort by which the mind throws itself into the state into which it might have been brought by the former ideas recurring of themselves. In Perception we do not voluntarily throw the mind into the state of Sensation; we draw an inference from that sensation according to your theory. But I think it pretty clear that there is something between the sensation and the inference—the simple apprehension and the conclusion drawn. The latter is clearly an inference that an external being exists which created the sensation and the perception. But I think there is also a perception upon the sensation, and which cannot certainly exist without it. However, be this as it may, to our present purpose it makes no difference, except as far as there can be no doubt of the mind being in a much more passive state in the two conditions of feeling and remembering than in the other two of recollecting and perceiving.

A. Then of Imagination we have already disposed. It consists of the successive, though rapidly succeeding operations of other faculties whereby we create or combine new ideas that had no previous existence, abstracting the qualities of one object to clothe another with them. But Abstraction we may allow to be a simple operation and one of the most important. What do you make of two that I do not remember you to have named, Attention and Conception?

B. I omitted them purposely. I can see really nothing in Attention but the degree in which certain other faculties operate. It is only the inten-vith which I perceive. Possibly there may me good from considering it as the difference een Perception and Sensation: in the latter the mind passively receives the impression of enses; in the former it fixes itself steadily upon e impressions, so as to feel them by a voluntary t more acutely. As for Conception, which formerly to be called Simple Apprehension, it aly the forming ideas of objects neither pre-ed by the senses nor by the imagination; and I unable to separate it from Memory and from traction—from memory as far as it deals with er ideas, from abstraction as far as it deals with ity apart from the objects remembered or ima-d.

. Then Judgment being the comparison of s, and Reasoning the comparison of judgments, is, of the ideas arising from the former compa-ı, may be set down as one faculty—that of paring—and I conclude you make quick work Taste and the Moral Sense, of which the one s us preferences among objects of mental gra-tion, and the other among objects of moral obation?

'. They are both evidently exercises of the ing and reasoning powers,—say the comparing ers, according to two standards,—the one the e of beauty or fitness, of what is pleasing or eable; the other, the sense of what is just and t. But whether this last sense is natural or ired, and how acquired, is a question that has divided philosophers, and which will very inly never be determined. Nor is it more to determine the other, which is quite a kin-one, how it is that our taste is formed, and whether it be natural or acquired. All that we can say on this subject is, to remark the little practical importance which belongs to either question; and to state that, as far as our present discussion is concerned, the only faculty involved in either one or the other is that by which we compare different ideas.

A. Our enumeration then of mental faculties seems to resolve into Perception, active or passive; Memory, active or passive; Consciousness, Abstraction, and Comparison; then how do we place animals as to the first?

B. Clearly no animal, nothing having life, can be conceived to exist, without Passive Perception at all events, and hardly any without Active Perception also. Consciousness too seems a necessary quality of every mind; it is the knowing one's own existence; so Memory of the passive kind must exist in every mind; without Consciousness and Memory no animal could know its own personal identity; and no acts could be done by it upon the supposition of that identity. With respect to Active Memory and Conception, if this is to be held a separate faculty, it is implied in Comparison, or in judgment and reasoning; so that our inquiries come to be confined within sufficiently narrow limits. Do the lower animals possess Abstracti and Comparison? I will at once begin with A straction, because it is the power most genera denied to brutes; and this arises, as I concei from an ill-grounded notion of its nature, and fi a supposition that it is a faculty of a far more fined nature, subservient to operations of a m more difficult kind, than the truth will warrar in affirming. The truth appears to be, that are, if not two kinds of Abstraction, an active and a passive, yet certainly some degrees of Abstraction so easy and even unavoidable, that we can hardly conceive almost any mind incapable of forming them. But on the other hand, the very highest and most difficultly attained reach of human thought is connected with Abstraction. Observing this, philosophers have passed all under one name, and because the brutes could not conduct algebraical investigations or metaphysical reasonings, have denied them all power whatever of forming abstract ideas.

A. To a certain degree this is no doubt true. The abstraction by which we reason upon m and n or x as only numbers; deal with x the unknown quantity, multiplying it and speaking of m times x, or dividing it and speaking of one n^{th} part of x, is no doubt a high and refined reach of thought; but so is the forming to ourselves an idea of abstract qualities; indeed I know not if, when we reason about m and x, we do more than mechanically deal with the letters; whereas in reasoning of colour or smell as abstracted from the rose with which we always have seen them conjoined, and forming to ourselves the idea of something in the abstract which we have only ever seen in the concrete,—of some ideal existence of which in actual existence we have never known anything, nor can know,—we really appear to go a step further. Now do you maintain that Abstraction is ever otherwise than a difficult and painful operation?

B. First of all be pleased to observe that many philosophers altogether deny, even to man, the power of forming abstract ideas. The dispute of the *Nominalists* and *Realists*, so well ridiculed by Swift, or rather by Arbuthnot in Scriblerus, is as old as metaphysical inquiries, under one name or another. They consider it impossible for us really to form these abstractions, and hold that we only are using words and not dealing with ideas, just as you seem to think we do in algebraical language. Mr. Stewart is among those who conceive that we think in language. My opinion, if against such venerable authority I may venture to hold one, is different. I think we have ideas independent of language, and I do not see how otherwise a person born deaf and dumb and blind can have ideas at all; which I know they have, because I carefully examined the one of whom Mr. Stewart has given so interesting an account. Indeed he has recorded the experiment of the musical snuff-box which I then made upon this unhappy but singular boy. But next I am to show you that abstraction independent of algebra, or metaphysical reasoning altogether, is neither difficult nor painful. Without Abstraction we cannot classify in any way, or make any approach to classification. Now I venture to say that no human being, be he ever so stupid, is without some power of classification, nay, that he is constantly exercising it with great care, and almost unavoidably, and acting upon the inferences to which it leads. He can tell a man from a horse. How? By attending to those things in which they differ. But he can also tell a stone from both, and he knows that the stone is different from both. How? By attending to those things in which the two animals agree, and to those things in which they differ from the stone. So every person having accurate eyes and the use of speech can call a sheet of paper and a patch of snow both white; a piece of hot iron and of hot brick both hot. He has *therefore* the idea in his mind of colour and of heat in these several cases, independent of other qualities, that is, abstracted from other qualities; he classifies the white bodies together, independent of their differences; the hot bodies, independent of theirs; and he contrasts the white metal with the white snow, because they differ in temperature, without regarding their agreeing together in colour. All this is Abstraction, and all this is quite level to the meanest capacity of men. But is it not also level to brute intellect? Unquestionably all animals know their mates and their own kind. A dog knows his master, knows that he is not a dog, and that he differs from other men. In these very ordinary operations we see the animal mind at one time passing over certain resemblances and fixing on differences; at another time disregarding differences and fixing only on resemblances. Nay, go lower in the scale. A bull is enraged by a red colour, be the form of the body what you please. A fish is caught by means of a light, be it of any size or any form.

A. These things which you last mention are mere sensations. The red light or the flame impresses the retina and affects the animal's sensorium, his brain—irritating the quadruped, and attracting the fish.

B. What then? Other sensations pass to his mind through his senses at the same time. He has the sensation of form as well as colour; yet he passes this entirely over, and only considers the colour. However, take those cases in which animals are attracted to certain places. They are hungry and go to a certain field to eat, without the least regard to its position or its shape; because it agrees with other fields in bearing the food which the beast is in quest of. Flies approach the light because they believe it to be the open air where they wish to go. So the bird never throws stones into a river or puddle to raise the water; but it does throw them into the ewer. It abstracts water from the thing containing it; and could not reason upon the effects of the operation without a process of Abstraction. Indeed, upon the footing on which you would put it, I know not that all our own abstract ideas may not in the end be resolved into sensations and their immediat consequences. I know of no evidence that yo have of our abstract ideas being formed in any othe way, except on our consciousness, and our cont nual communication of ideas and experience throug speech. In the case of the brute we have all t same phenomena, and, excluding the operation blind Instinct, we are forced to the like conclusio

A. I think we may go a step further; have n animals some kind of language? At all eve they understand ours. A horse knows the e couraging or chiding sound of voice and whip, a moves or stops accordingly. Whoever uses t sound, and in whatever key or loudness, the ho acts alike. But they seem also to have some kno ledge of conventional signs. If I am to teach a d or a pig to do certain things on a given signal, t process I take to be this. I connect his obedie with reward, his disobedience with punishme But this only gives him the motive to obey, t fear of disobeying. It in no way can give him t means of connecting the act with the sign. N connecting the two together, whatever be the ma ner in which the sign is made, is Abstraction; b it is more, it is the very kind of Abstraction

hich all language has its origin—the connecting
e sign with the thing signified; for the sign is
rely arbitrary in this case as much as in human
nguage.

B. May we not add that they have some con-
ntional signs among themselves? How else are
e to explain their calls? The cock grouse calls
e hen; the male the female of many animals.
he pigeon and the fieldfare and the crow make
gnals; and the wild horse is a clear case of sig-
als. All this implies not only Abstraction, but
at very kind of Abstraction which gives us our
nguage. It is in fact a language which they pos-
ss, though simple and limited in its range.

A. As to the power of comparing, what is com-
only called Reason, *par excellence*, comprising
udgment and Reasoning, this needs not detain us
ery long. The facts here are not well liable to
ispute. There is no possibility of explaining the
any cases which we began by going over without
llowing this power. They all prove it in some
egree. Several of them show it to exist in a very
onsiderable degree. The acts of some birds and
onkeys cannot be accounted for by Instinct; for
hey are the result of experience; and they are
erformed with a perfect knowledge of the end in
iew; they are directed peculiarly to that end;
hey vary according as the circumstances in which
hey are performed alter, and the alteration made
s always so contrived as to suit the variation in the
ircumstances. Some of these acts show more sa-
acity, according to Mr. Locke's observation, than
s possessed by many men. The existence of a
omparing and contriving power is therefore plain
nough. And on the whole I conceive that a ra-

tional mind cannot be denied to the animals, however inferior in degree their faculties may be t our own.

B. That inferiority is manifestly the cause wh they have made so little progress, or rather hav hardly made any at all. Some little is proved b such facts as Mr. Knight has collected, but the are only exceptions to the rule which has doome them to a stationary existence. This difference however, is merely the result of the inferior degre of their mental powers, as well as the different construction of their bodily powers. The want o fingers endowed with a nice sense of touch is an obstruction to the progress of all, or almost all, th lower animals. The elephant's trunk is no doub a partial exception, and accordingly his sagacit is greater than that of almost any other beast. Th monkey would have a better chance of learning th nature of external objects if his thumb were not o the same side of his hand with his fingers, whereb he cannot handle and measure objects as we do whose chief knowledge of size and form is derive from the goniometer of the finger and thumb, th moveable angle which their motion and positio give us. Insects work with infinite nicety by mean of their antennæ; when these are removed the cease to work at all, as Huber clearly proved Clearly this different external conformation, together with their inferior degree of reason, is sufficient to account for brutes having been stationar and for their being subdued to our use, as the Deit intended they should, when He appointed this difference. To argue from the complex effect of al the faculties, bodily and mental, in giving differen progress or power to our race and to theirs, and t infer from this difference that there is an essential and specific diversity in our mental structure, nay that they have not one single faculty the same with ours in kind, is highly unphilosophical. It is indeed contrary to one of the fundamental rules of philosophizing, that which forbids us needlessly to multiply causes. For we are thus driven to suppose two kinds of Intelligence, human and brutal, and two sets of faculties, a Memory and a Quasi Memory, as the lawyers would have it—an Abstraction and Reasoning, properly so called, and something in the nature of Abstraction and Reasoning, but, though like, yet not the same.

A. There is one matter to which we have not as yet adverted, but, after having considered the intelligent as well as instinctive powers, we may now as well do so. I mean the diversity in the operations of the latter, and the perfect sameness of the former —a sameness in all the operations of any given individual animal, and likewise of each of the species.

B. This is well worthy of consideration. When trying to explain instinctive operations upon the hypothesis of an intelligent principle acting under the impulse of sensations, I found in this perfect sameness and regularity of its operation a considerable difficulty, though not perhaps an insuperable one, not certainly so great a difficulty as those we have considered.

A. How did you endeavour to explain, on that hypothesis, the regularity of Reason or Intelligence?

B. The absolute sameness of moral and intellectual character, and the limited sphere of ideas and events, will account for much. We see far less diversity of action and speech among peasants of a very confined knowledge and very limited range of pursuits, than among persons of a higher degree of education and superior station in life. But still there is a great diversity. Taking, however, two men of most perfect resemblance in all their faculties, and all their feelings, similarly constituted in both body and mind, they would probably act nearly if not entirely alike. Whatever made one do a thing would make the other, and we must suppose them to be placed in perfectly similar circumstances, so that the same things would happen to both. Chance is here to be put out of view; because it only means ignorance of motives and circumstances, and assumes a diversity in these unknown to us, which by the supposition is here excluded. Suppose these two individuals thus placed in like circumstances as to food and building materials, why should they eat differently, or make different habitations? What is there to make the one choose a plant which the other does not choose? or form a hut in any particular different from the other? If one kind of food was nearer the one, and another nearer the other individual, they might choose differently; but this assumes that both kinds are agreeable to the constitution of their palates.

A. As long as providing for merely physical wants was their whole occupation, it is probable that both would act alike, except that, if any difficulty occurred to be vanquished, I am not at all sure of their adopting the very same means to overcome it. One might break a nut with his teeth, another with a stone, or by bruising two nuts together. But there is the same diversity in the conduct of animals where they act by intelligent principles. The general resemblance of their proceed*ings is* explained by the consideration you are stating in the case you put of the boys. Their instinctive operations would never vary in the least particular. When they came to reason, or speculate, or converse, the sameness would probably cease. It seems inconsistent with imagination and with free will; yet of this I speak doubtingly, considering the hypothesis you have made of faculties and feelings perfectly alike in all respects.

B. Certainly, you ought to speak doubtingly, when such is the hypothesis that is now binding us. I do not see how, even in reasoning, anything should ever come into the mind of the one that did not suggest itself to the other. But our hypothesis s not easy to remain under. Suppose, to make the case like instinct, two untaught children in different parts of the country, viz., one in China and the other here, to be placed in a situation where the ame kinds of food and building materials were placed, and a variety of each, we may assume that imilar tastes and constitution of mind and body would make them eat the same things, perhaps hoose to shelter themselves by building rather han by going into caves, possibly to build with he same materials selected out of a number; but t is much to say that they would exactly preserve he same figure and size and proportions in the uts they made. Each would certainly make blun- ers, and work inartificially; and it is difficult to ancy them exactly making the same blunders, de- iating from the straight line or the circle by the ame quantity of aberration, and from the perpen- icular by the same angle: yet the bee in China nd in England makes the same angles, and forms ells with the same proportions, and raises the grub he same height from the liquor provided for its nutriment, so as to let it have access to the liquor without incommoding or drowning it.

A. When instinct is interfered with by obstacles interposed, the animal's intelligent powers are brought into action, and then the uniformity and perfect regularity ceases. This seems to present under this head, as well as the other head of knowledge and design or intention, a sufficiently marked distinction.

B. Certainly: and it is to be observed that the more sagacious any animal is, the greater variety is perceived in his actions and habits. Thus the elephant and the dog present general resemblances throughout each species; but the instances of sagacity or reason which the different individuals exhibit are sufficiently various: whereas there is no more diversity in the ordinary working of the bee, than in the operations of crystallization, or the secretion of the sanguiferous or the lacteal system. In truth, we may compare the two cases together. Instinct seems to hold the same place in the mental which secretion and absorption do in the physical system. Intelligence or reason will sometimes interfere with Instinct, as our voluntary actions will interfere with the involuntary operations of secretion. But the instinctive operation proceeds whether the animal wills or no—proceeds without his knowledge, and beyond his design—as secretion goes on in our sleep without our knowledge and without any intention on our part. So as secretion goes on without any help from us, or any direct co-operation, Instinct works without any aid from Intelligence. But there is this difference in the connexion of will or Intelligence with Instinct, and the *connexion* of voluntary action with secretion—that the Instinct seems subservient to the intelligent will far more than the secreting power is to the voluntary action. The bee, when obstructed, applies his Instinct, as it were, to overcome the obstacle, whereas we cannot alter at will the course of secretion; we have some direct power over it, but very little.

A. One thing seems quite clear, that upon any view of this great question, whatever theory we adopt, all leaves the inference of design untouched; nay, the more we inquire, the more we perceive that all investigation only places in a stronger light the conclusion from the facts to a superintending Intelligence.

B. Beyond all doubt it is so. The whole question is one of relations and connexions. Adaptation—adjustment—mutual dependence of parts—conformity of arrangement—balance—and compensation—everywhere appear pervading the whole system, and conspicuous in all its parts. It signifies not in this view whether we regard Instinct as the result of the animal's faculties actuated by the impressions of his senses—or as the faint glimmerings of Intelligence working by the same rules which guide the operations of more developed reason—or as a peculiar faculty differing in kind from those with which man is endowed—or as the immediate and direct operation of the Great Mind which created and which upholds the universe. If the last be indeed the true theory, then we have additional reason for devoutly admiring the spectacle which this department of the creation hourly offers to the contemplative mind. But the same conclusion of a present and pervading Intelligence flows from all the other doctrines, and equally flows from them all. If the Senses so move the animal's mind as to produce the perfect result which we witness, those senses have been framed and that mind has been constituted, in strict harmony with each other, and their combined and mutual action has been adjusted to the regular performance of the work spread out before our eyes, the subject of just wonder. If it is Reason like our own which moves the animal mechanism, its modification to suit that physical structure and to work those effects which we are unable to accomplish, commands again our humble admiration, while the excellence of the workmanship performed by so mean an agent impresses us with ideas yet more awful of the Being who formed and who taught it. If to the bodily structure of these creatures there has been given a Mind wholly different from our own, yet it has been most nicely adapted to its material abode, and to the corporeal tools wherewith it works; so that while a new variety strikes us in the infinite resources of creative skill, our admiration is still raised as before by the manifestation of contrivance and of expertness which everywhere speaks of the governing power, the directing skill, the plastic hand. Nor is there upon any of these hypotheses room for doubting the identity of the Great Artificer of nature. The same peculiarity everywhere is seen to mark the whole workmanship. All comes from a Supreme Intelligence; that intelligence, though variously diversified, preserves its characteristic features, and ever shines another and the same.

NOTE TO THE DIALOGUES.

N Dialogue I. the Instinct of the duckling hatched nder the hen and of the chicken in the oven is menioned. The two following facts have occurred since hat discussion was ended.

When a sow farrows, the pigs are expelled with some orce, and to a little distance, by the action of the uterus nd abdominal muscles. Each pig instantly runs up to ne of the teats, which he ever after regards as his own eculiar property; and when more pigs than teats are proluced, the latter ones run to the tail of some of the others, nd suck till they die of inanition.

Mr. Davy in his account of Ceylon mentions a remarkble Instinct of the alligator. He saw an egg in the and just ready to crack, and broke it with his stick. The nimal came out, and made at once for the river. He eld his stick before it, and immediately the reptile put tself in a posture of defence, as an adult alligator would ave done in like circumstances.

In Dialogue III. there is some doubt expressed as to he water-moth loading its case, if too light in the water, vith a kind of ballast. The larvæ of the *Phryganea* are tated by Mr. Lyell to do this habitually, and to use resh-water shells for their ballast. This gives rise to nany masses of calcareous matter in the tertiary formaions. As many as 100 small shells are found surrounding ne tube. (*Principles of Geology*, vol. ii. p. 232.)

In Dialogue IV. some remarks are made upon Hereitary Instincts. Mr. Roullin has related a similar intance of such Instinct in the hunting dogs of Mexico. Were they to attack the deer in front, whose weight exceeds their own sixfold, they would be destroyed and have their backs broken, as happens to other dogs ignorant of the manœuvre, which consists in attacking from behind or laterally, and seizing the very moment when the deer, in running, rests upon two legs. The dog then takes hold of him by the belly and throws him over. The dog of pure breed inherits this stratagem and never attacks otherwise. Should the deer come upon him unawares (from not seeing him), he steps aside and makes his attack at the proper time in the animal's flank; other dogs, however superior in sagacity and strength, make the attack in front, and have their necks broken by the deer. So too some of our English miners carried out greyhounds to hunt the hares in Mexico. The air on that elevated platform, 9000 feet above the level of the sea, is so rare that the mercury stands at 19 inches generally, and the dogs were soon exhausted with running in such an atmosphere; but their whelps are not at all incommoded by it, and hunt as easily as the dogs of the country.

Respecting the elephant, extraordinary accounts are told by military men who were in the Burmese war. They relate that when any extra task is to be performed by them, some favourite dainty is held up beforehand, and the sagacious animal, comprehending the promise of reward thus implied, exerts himself to earn it. This comes to the principle of barter as near as may be.

ON THE GLOW-WORM.

The facts relating to the light of this and other similar insects are by no means accurately known; and upon some material points able observers differ widely. Thus it was deemed very natural to suspect that some inflammable matter in a state of slow combustion caused the luminous appearance, the rather as it bears a striking resemblance to the light emitted by phosphorescent bodies. *Accordingly* the obvious course was pursued by different experimenters, of exposing the insects to heat and to oxygen gas, to see if the light was increased; and exposing them to carbonic acid and hydrogen gases, to see if the light was then extinguished. Forster and Spallanzani affirm that they have tried this experiment, and found the result to accord with the theory; they assert distinctly that in oxygen gas, and on the application also of heat, the light is more brilliant, and that none is given out in hydrogen and carbonic acid gases. But Sir H. Davy found that the light continued in the latter gases not sensibly diminished, and that oxygen did not increase its brightness;* Mr. Macartney observed the light in vacuo and under water,† while Dr. Hulme found that it was extinguished in hydrogen, carbonic acid, and nitrous gases, although he could not perceive that oxygen gas increased.‡ There seems reason to suspect that these able men made their experiments on different species of the insect, and that the animal or vital powers which regulate the secretion, or the use of the luminous matter, were affected by the gases applied. For it is admitted on all hands that the living insect has a power of extinguishing the light independent of any mechanical operation by which it may cover over the shining part; and although the fire-fly has that part usually covered with its wings, and therefore only shines when flying, the glow-worm's light is constant, unless she restrains or extinguishes it by a voluntary act.

That some luminous matter is secreted by the insect there can be no doubt. The fact that boys in South America rub their faces with bruised fire-flies, to make them shine, is asserted by travellers; and this seems to render it probable that the glow-worm likewise secretes such an oil. But the experiments of an able chemist, Mr. Murray, have set this question at rest. He examined a box in which glow-worms had been kept, and found several luminous specks which they had left behind them. Some of these yielded a steady light for five or six hours. Mr. Murray says that the luminous matter is inclosed in a capsule of a transparent substance, which, when ruptured, lets out the matter in a liquid form of the consistency of cream. A French naturalist, M. Macaire, made some experiments upon this matter, the result of which differed materially in one respect from that of either Spallanzani, Davy, or Hulme; for he is said to have found that the presence of oxygen in the air prevents it from shining, a position not reconcileable with the worm shining in the atmosphere. But some of this author's experiments seem to furnish a solution of many difficulties; for their results refer the appearance to the animal functions. He found that the luminous matter is chiefly composed of albumen, and that any body which coagulates albumen destroys the shining quality; which it probably does by altering the albuminous state of the fluid. He also observed, that though a certain degree of temperature is necessary for it, a higher degree destroys it altogether; and also that common electricity has no effect in exciting it, but that voltaic electricity or galvanism does excite it. These observations, if accurate, are the most important that have been made upon this subject. They seem to indicate an immediate connection between the vital powers of the insect and its luminous quality; and they account satisfactorily for the diversity in the results of former observers, who operated upon the animal apparently without taking its vital functions into the account.

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* Phil. Trans. 1810, p. 287.

† Ib. 1810.

‡ Ib. 1801.

The glow-worm (Lampyris Noctiluca) is not the only luminous insect. There are several other kinds both winged and apterous. Of these the fire-fly, a species of the Elater and of the beetle tribe, has already been mentioned. Indeed all the species of the Lampyris genus are supposed to be more or less luminous. Several other species of the Elater, as well as the fire-fly, are also luminous. Some species of the Fulgaro (an hemipterous insect) shine so bright that they are called lantern flies. Of these the Fulgora Candelaria is a native of China, and the F. Lanternaria, which is two or three inches long, is a native of South America. The shining matter in these,

all others of the genus that shine at all, is confined
transparent bulb projecting from the head.* Two
ies of centipes, the Geophilus Electricus and G.
sphoreus, also shine; the former is a native of this
ıtry, the latter of Asia.

everal theories have been formed to explain the use
ıis luminous quality. It is observable that some of the in-
s which have it are apterous in one sex while the other
inged—as the glow-worm, the male of which is a fly,
female being a caterpillar. In others, both male and
ıle are winged. Again, some have the light always in
t, and it seems not to vary in brightness, as the Fulgora.
ıralists have supposed that in these it is serviceable in
ɔvering their prey. But it has also been suggested
defensive or protective purposes may be the final
e of the light. Insects which prey on caterpillars
been observed running round the Geophilus Electri-
as if afraid to approach it.† But there is one peculi-
in the glow-worm's light which seems to sanction
commonly received opinion of its use being chiefly, if
entirely, to attract and direct the approach of the
. Not only has the latter wings, and thus is by his
ts little likely to be found near the unwinged female
ıere is also found to be much less light emitted by
male; insomuch that at one time the female alone
believed to shine at all, until Ray corrected this error.
also remarked that the light is the strongest when
two are together, and that in some, if not all the
ies, the luminous quality is confined to the time when
are destined to meet. Nor is De Geer's objection,
ıded on the observation that the chrysalis and larva of
species have somewhat of the same luminous quality,
nuch force. For as the very learned entomologists
cited, Messrs. Kirby and Spence, have well observed,
instance may easily be set down with the analogous
of males having a kind of lacteal system in some ani-
s, including our own species. It deserves further to be
arked, that in Brazil there is a glow-worm which is

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* Kirby and Spence, ii. 413.

† Ib. ii. 225.

winged, both male and female, and the light this insect is not steady like that of our glow-v sparkles or intermits. On the other hand, th of Brazil is said to give a constant light.* But be owing to the greater luminousness of the tul the thorax, which in the European fire-fly giv light compared with the patches concealed by (elytra) of the wings, that they seem only to sh flying.

* Kirby, Bridgewater Treatise. ii. 366.

ANALYTICAL VIEW

OF THE

RCHES ON FOSSIL OSTEOLOGY,

AND

IR APPLICATION TO NATURAL THEOLOGY.

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RCHES ON FOSSIL OSTEOLOGY,

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IR APPLICATION TO NATURAL THEOLOGY.

Fossil Osteology.

at work of Cuvier stands among those rare
nts of human genius and labour, of which
artment of exertion can scarcely ever fur-
re than one, eminent therefore above all
er efforts made in the same kind. In the
sciences the 'Principia' of Newton, and
times its continuation and extension in
ce's 'Mécanique Céleste,'—in intellectual
hy, Locke's celebrated work,—in oratory,
enes,—in poetry, Homer,—* leave all
tors behind by the common consent of man-
nd Cuvier's Researches on Fossil Osteology
bably be reckoned to prefer an equal claim
ction among the works on Comparative
y. That this great performance deserves
tentively studied there can be no doubt.

English law were not a local learning merely,
work on Contingent Remainders would perhaps
be thus ranked. In the eloquence of the pulpit,
es nearer Massillon than either Cicero does, or
, to Demosthenes.

But as its bulk, in seven quarto volumes, may be apt to scare many readers, there may be some in giving a general account of the progress of the author's inquiries, and of the principal results which they led him, and more particularly in showing their application to Natural Theology.

Long before his attention was called to remains of animals found in various strata of earth, in more superficial situations, in crevices rocks, and in caves, he had, fortunately for been a skilful proficient in anatomy, both h and comparative. But the first steps of his quiries concerning those fossil remains showed how much he had yet to do before he could plicitly trust the received accounts of the structures. As regards the human subject, obvious reasons, the knowledge possessed which the ordinary works of anatomy cont accurate enough and sufficiently minute. B far otherwise with the structure of other an and especially as regards their Osteology. Cuvier found so many instances, that he his investigations with examining minute thoroughly the bones of all those species wh the resemblance of which, are supposed t furnished the materials of the great depo fossil bones so abundant in almost every part globe. This, then, was the course which h riably pursued; and he never attempted t any inferences respecting the fossil animal, until had accurately ascertained the whole Osteology the living species. There was obviously no other way of excluding mere fancy and gratuitous assumption from the inquiry, and making the science, of which he was really to lay the very

ion, one of pure reasoning from actual
tion, in other words, one of strict induction.
ie course of his work there are to be found
g examples of the mistakes into which for-
quirers had been led by neglecting this pre-
i. Partly by relying on incorrect, though
lly received, descriptions,—partly by under-
g the requisite comparisons of the fossil with
iown bones,—partly, no doubt, by giving
to fancy, observing the remains discovered
he bias of a preconceived opinion, and making
ict bend to a theory—authors had com-
the most grievous errors, hastened to con-
is wholly unwarranted by the facts, and often
inferences which the facts themselves nega-
instead of supporting. Thus M. Faujas de
nd, a geologist of great learning and experi-
ut who had upon a very scanty foundation
a dogma, that all the fossil remains be-
to animals still found alive in different parts
earth, and set himself to deny the novelty
the fossil species of unknown animals, con-
that he had at length himself found among
remains two animals which, if they still
at all, could only be found in the interior
note parts of India. Of these supposed dis-
s he published the drawings, representing
ssil heads. But Cuvier, upon examination,
one of them to be exactly the auroch or
and the other the common ox.[*] A more
naturalist, Daubenton, describes three sets
l teeth, in the King of France's cabinet, as
ing to the hippopotamus; and upon examina-
o of these sets are found to be teeth of two

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[*] Recherches, vol. iv. p. 108.

new and unknown animals,* and the third alone those of the river horse; and Camper, one of the greatest anatomists of his age, fell into a similar error. Upon the discovery of some fossil bones in the Duchy of Gotha, there was a general belief that they were some *lusus naturæ*, and several medical men wrote tracts to prove it. But a nearer inspection proved them to be elephant's bones.† The town of Lucern took in earlier times for the supporters to its arms a giant, from the opinion pronounced by a very celebrated physician (Felix Plata), that the bones discovered in that canton were human and gigantic, though Blumenbach afterwards examined them, and found they belonged to the elephant. Finally, Scheutzer maintained that there were remains in different places of men who had perished in the general deluge, and supported his opinion by several instances to which he referred. Upon examination these have proved to be none of them human bones; but one set are those of a water salamander, while another belong to a newly discovered animal still less resembling our species, being something between a lizard and a fish.‡ When professional anatomists and professed naturalists could fall into such mistakes as these, there is little wonder that a statesman like Mr. Jefferson, however illustrious for higher qualities, should commit a similar blunder. He drew from the fossil bones discovered by General Washington near his seat in Virginia, and to which his attention was directed by that great man, the conclusion that they belonged to an enormous carnivorous animal, which he named

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[*] Recherches, vol. i. p. 305. [†] Ib. p.120.

[‡] Ib., vol. v. pp. 433 and 451.

lonyx. Cuvier, from a more correct ex-
, showed the creature to have been a
large dimensions, and which fed wholly
roots of plants.

se examples, and they might be very
ultiplied, evince the necessity of a cau-
mination, and of a previous attention to
logy of animals with which we are fully
d, the success of Cuvier's inquiries also
t, with due care and circumspection, the
f the inquirer is sure. The connexion
the different parts of the animal frame is
and certain, and the species run so little
another, that it requires but a small por-
y animal's remains to indicate its nature,
tain the class to which it belongs. Each
rtion, so it be superficial, of bone—each
y eminence—has its distinctive character
pecies; and from one of these, or some-
m a piece of horn, or of hoof, or a tooth,
animal may be determined. "If," says
"you have but the extremity of a bone
rved, you may by attention, consideration,
aid of the resources which analogy fur-
skill, determine all the rest quite as well
u had the entire skeleton submitted to
Before placing entire reliance on such an
, this great observer tried many experi-
fragments of the bones of known animals,
a success so unvaried as gave him natu-
licit confidence in his method when he
xamine Fossil Remains.

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rches, vol. i. p. 52. We have used the expression
he author says animal, but manifestly, from what
is is incorrect.

greater number of living genera of animal the copper slate of Thuringia, the lias of E the clay of Honfleur, and the chalk—in the the remains of reptiles are found with exti cies of marine shells, but no vertebrated higher than fishes; or, *secondly*, in the st posited by the sea, after it had destroyed races, and covered the land they lived upo in these beds, which at Paris lie on the ch to be found only animals now extinct, and most of the genera and all the species dif any we now see;—or, *thirdly*, in the strat sited by the sea, or in fresh-water lakes,- these later tertiary beds are to be found now unknown, but resembling the presen being different species of the same genera parently of families still living, but not nc biting the same countries, or living under t climates;—or, *fourthly*, in places where lakes, morasses, turf-bogs, have buried the of existing species; and as these change limited extent have happened to the glol stituted as it still is, those animals appear been for the most part identical with the which we still see alive in various part world, at least as far as their skeletons can

Paris is the centre of a most extraordin logical district. It is a basin of twenty between fifty and sixty English miles, in d extending in a very irregular form from near Compiegne on the north, to the Canal beyond Fontainebleau on the south, an Mantes on the Seine upon the west, to Mo *on the* east; comprehending within its ci *towns of* Paris, Versailles, Fontainebleau, E

Meaux, Melun, Senlis, Nangis, and coming close to Soissons, Gisors, Beauvais, Montereau on the Yonne, Nogent on the Seine, and Condé; but not being continuous within these limits, for it is frequently cut off in islands, and every where towards the outline deeply indented with bays. This vast basin consists of six different formations, in part calcareous, but in some of which gypsum is so plentiful, that the quarries dug in it go by the common name of the Plaster of Paris quarries, and indeed gypsum has derived it common name from these. The lowest bed upon the chalk is composed of plastic clay, and it has covered both the plains and the caves of the district. This bed is full of fossil remains, very many of them belonging to unknown animals, and it also contains fragments of rock, which have come from a great distanee. Above this bed is a layer of gritty limestone and shelly grit, of salt-water formation. Then come in succession silicious limestone, fresh-water gypsum, and sand and grit without shells. The fourth formation is sandy, and of marine origin. The fifth has fresh-water remains and animals. The disposition of the land around and forming this basin wears in all respects the appearance of having been broken in upon and hollowed out by a prodigious irruption of water from the south-east. Considerable corrections have since been made, especially as regards the second and third of these formations of Cuvier.

It appears that the base or bottom of the Paris Basin must have been originally covered with the sea. Different parts of the ground were then covered with fresh-water lakes, from which gypsum and marl were deposited, filled with the bones of animals that lived on their banks or in their islands,

and died in the course of nature. After this de
sition, the sea again occupied the ground, a
deposited sand mixed with shells; and when it l
the land dry for the last time, there were for a l
while ponds and marshes over the greater part
the surface, which thus became covered with st
containing fresh-water shells, the base of th
strata consisting of a peculiar stone found in fr
water, and occurring in many parts of France. T
fossil remains in this great basin exhibit little
riety of families; and the vegetable remains sh
that the plants were confined to palms and s
others now unknown in Europe. As the gr
continents, which offer a free communicati
throughout, are inhabited by a great variety
animals, while New Holland and the other isla
in the South Seas have only a very few, and th
almost all of the same family, we may concl
that the land forming the Paris Basin was origina
surrounded by the sea.

The deposits in the rents or fissures of the str
may now be briefly mentioned, and they presen
very singular subject of contemplation. They a
found all around the Mediterranean, at Gibralt
Cette, Antibes, Nice, Pisa; in Sicily, Sardinia, a
Corsica; at the extremity of the kingdom of N
ples; on the coast of Dalmatia; and in the island
Cerigo. The body of the deposit is calcareous, a
of the same kind in all these gaps or fissures. T
same, or nearly the same, bones are everywh
found imbedded in it; they are chiefly the bo
of ruminating animals; and beside those of ox
and deer, there are found those of rodents, a ki
of tortoise, and two carnivorous animals. In th
fissures there are many land but no sea shells; a

:ter that fills them is unconnected with other It follows from the first fact that they must een consolidated before, and at the time he sea came over those countries and deshell-fish in the other strata; and from the fact it follows that they must have been when the rocks, in the rents of which they ıd, were already formed and dry. Hence these leposits are modern compared to the strata vere formed at the bottom of the sea and ;. Nor does any operation now going on ur globe bear the least resemblance, in s judgment, to that by which those deposits ve been made. Upon this, however, great ersy has arisen among his successors.

s necessary that we should shortly advert laces where, for the most part, these fossil are found; in doing so we have anticipated the conclusions deduced from the consiof the whole subject. We are now to see sults were afforded by Cuvier's careful exa- of the remains, which he instituted after vith equal care ascertained the exact Osteothe living animals in each case where the mains appeared to offer a resemblance with tribes.

irst part of Cuvier's researches is occupied *pachydermatous** animals whose remains d in alluvial deposits.

econd part consists of two subdivisions—in hich are given minutely the whole details aris Basin—in the other subdivision the exaof the animal remains, beginning with the rmatous, and then the others that accom

als with thick skins, as the elephant, horse, hog.

pany them, whether quadrupeds, reptiles birds. So that the Paris Basin is made of this arrangement, and its Fossil Zoolo through without much regard to the g rangement of the rest of the work.

The *third* part is occupied with the animals, unless in so far as one of its s treating of the gaps or fissures of the Med also treats of the few other animals there found beside the ruminant.

The *fourth* part is occupied with c animals—the *fifth* with *rodents*—the *toothless* or *edentate* animals—the sev *marine mammalia*—the *eighth* and last, haps the most interesting of the whole, wit including the anomalous species newly d which partake of the nature at once of t and fish or of the reptile and bird.

As no arrangement is yet made of th animals under any of the heads which stated, we are at liberty to adopt any orde appear most convenient; and we shall a begin with those which at first appeared ble the known species of the rhinoceros, popotamus, and the elephant, and which observer would unquestionably have c with these animals; but they were soon a to be different.

I. Of the fossil rhinoceros four distin have been found;* and they are all disti from the four known kinds of rhinoceros India, Java, Sumatra, and the Cape. animal had a head both larger and narr ing kinds, and much larger in proportion to dy. He was also much lower, and a more ıg animal. He, for the most part, had either sive teeth or very small ones, but one species ese of a good size. One of the fossil species nguished from all the four known ones and he other three fossil ones, by a still more l peculiarity; his nostrils are divided from ther not by a gristly or cartilaginous, but by partition, whence the name of *Tichorhinus*[*] en given to him, the three others being termed *hinus*,[†] *Incisivus*, and *Minutus*.

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* Of these there are now nine species, five discovered since Cuvier's work.

grinding teeth of the Tichorhinus are also to have a peculiarity which no other teeth of any living or any fossil animal have. They lented at the base in one of the ridges, after worn down by use. This, as well as the bony on, affords, therefore, the means of discovering ecies. The use of the partition apparently support the weight of two large and heavy on the nose.

history of the first of these species, the hinus, furnishes a remarkable example of ors into which even able and expert observers all when they make more haste than good to reach a conclusion. A missionary named ell having sent home the head of a rhinobeing one of several killed close by his resiand well known to have been so, Sir Everard compared it with a fossil head from Siberia, y the Emperor of Russia to Sir Joseph s; and finding, as he thought, that it was of ne species, he very rashly inferred that the n which affirms the existence of unknown

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om Τειχος, a wall.

[†] From Λεπτος, slender.

animals among the fossil remains - was much weakened by this supposed discovery. Cuvier made a more accurate comparison, and found that the Cape skull was materially different from the fossil one, but resembled the head of the existing species, which Sir Everard Home had also denied. The most remarkable omission, however, of the latter was his never looking to see if there existed a bony partition between the nostrils. This Cuvier did, and found it cartilaginous and not bony. So that the most singular of the new and unknown fossil animals belonging to this class remained still a novelty, even if Sir Everard Home had been correct in all the comparative examinations which he ever did make; and his conclusion of fact from that comparison, even if admitted to be well founded, had no bearing whatever upon the general position against which he had pointed it.

The extraordinary fact of a portion of one of these ancient and lost animals' muscular substance and skin having been found, is further to be mentioned. In a block of ice on the banks of the Wilujii, a river of Siberia, there was discovered this huge mass of flesh, about the year 1770. It was found to have longish hair upon parts on which the existing rhinoceros has only leather; consequently it must have lived in a colder climate than the present animal inhabits. But it appears to have been killed by some sudden catastrophe, and then to have been immediately frozen, else it would have undergone decomposition like the other remains of which the bones alone are left.

There are two species of living elephants, the African and the Asiatic; the former distinguished from the latter chiefly by the length of his tusks, eculiar disposition of the enamel in the jaw and by never having been tamed, at least dern times. The fossil elephant resembles the ic species most, but differs in some material ulars. It has long tusks, sometimes exceeding eet in length; the jaw teeth are differently set; nder jaw of a different shape, as well as other ; and from the length of the socket bones of usks the trunk must have been also very dif- t. These remains[*] are found in great abun- both in Europe and in America, in neither of h parts of the globe are there now any living ants of any species produced. In the same and caves other animals are also found both e known and extinct classes; and occasionally also. The elephants' bones are chiefly dis- red on plains of no considerable elevation and the banks of rivers. They never could have transported by the sea over the mountains of ary, upwards of 20,000 feet in height, which ate Siberia from the parts of Asia where the ant now flourishes. It must be added, that, e those bones, a still more perfect specimen of ofter parts has been preserved by the action of than we have of the rhinoceros. In the same try, near the mouth of the river Lena, a mass was found in 1799 by a fisherman, which he not break or move; but in the course of the summer it partially melted, when it was found ntain an entire elephant frozen. The neigh- ng Tartars with their dogs, and afterwards the , destroyed the greater part of the flesh, but kin and bones were saved. It was found to

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ere are now known eight species of this fossil elephant.

have hair, and even woolly hair or fur, upon different parts of the body. It must then have been calculated, like the animal of the Wilujii, for living in a climate much colder than that of India or Africa, and, like that rhinoceros, it must have been frozen immediately after its death. Its tusks were circular, and nine feet (near ten English) long.

Of the hippopotamus, two species* have been found among the fossil bones, both so different from all living animals, that every one bone of each differs from any other known bone; so that even if an error should have been committed in connecting the different bones together, there must be not only two, but more than two, new species thus discovered. These animals abound in the great deposit of fossil bones in Tuscany, in the valley of the Arno, and at Brentford in Middlesex. There are two other fossil species, of which, however, less is known; one of these is very small, not larger than a common hog.

Three pieces of a jaw-bone, with some fragments of teeth, have been found in Siberia; which upon examination prove to have belonged to a singular species, resembling both the rhinoceros and the horse, and forming probably the link between these two animals. The size is larger than the largest fossil rhinoceros. The discoverer, Mr. Fischer, has named it the *Elasmotherium*,† from the thin enamel plate which winds through the body of the tooth in a peculiar manner.

But much more is known of a lost species which approaches the elephant, although differing in some important respects both from the living and the fossil elephant. The most remarkable difference in the Osteology is presented by the jaw teeth, which have the upper surface mamellated or studded with nipples; from whence Cuvier named it the *Mastodon.*[*] When these tubercles are worn down by use, the surface of the tooth has a uniformly plane or uniformly concave surface. The structure of the vertebræ shows it to have been a weaker animal than the elephant; and the belly was considerably smaller. The lower part of the fore-leg was longer, and the upper joint shorter; the shoulder one-ninth shorter too. The pelvis was more depressed; the tibia and thigh bones materially thicker; and the body a good deal longer in proportion to the height. As it fed upon vegetables, and had a short neck and feet unfit for living in the water, it must have had a trunk; and it also had tusks. It seems to have fed upon the softer parts of vegetables, and to have inhabited marshy ground. Six species[†] have been discovered of this animal, chiefly differing from each other in the teeth; and of these six, two only are well known. The mastodon was long supposed to be peculiar to America, and was sometimes called the Ohio animal; but there have since been found teeth in different parts of Europe, evidently belonging to the two better known species; and the other four kinds are, to all appearance, European.

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* Two more species have since been found.

† Ἐλασμος, thin plate.

In the same strata with the remains of elephants, rhinoceroses, and other animals both of extinct genera and species, are almost everywhere found the bones and teeth of horses, very nearly resembling those of the animal now so well and universally known. It yet happens that for want of due attention to a branch of anatomy more familiar to us than any except the human, naturalists have constantly fallen into error in examining fossil bones. Thus Lang, in his history of the figured stones of Switzerland, took a horse's tooth for a hippopotamus's; and Aldrovandinus in one work describes teeth of that class as giants', and in another as horses'; while several authors have confessed that they could not tell to what tribe such remains had belonged. Cuvier did not, therefore, deem himself released from the duty of fully examining the common horse's osteology, merely because of the frequent and minute descriptions which had previously been given of it; and his intimate acquaintance thereby obtained with the nature of every bone and tooth, has enabled him to pronounce with confidence upon the existence of horses like our own among the unknown animals which inhabited the earth before the vast revolutions that changed both its surface and its inhabitants. He has, however, justly noted the fact that there is no distinguishing the bones of the horse, the ass, the mule, and the quagga; so that very possibly these remains may have belonged to any of those animals; and very possibly also to none of them, but to some fifth species, now, with the mastodon and other contemporary animals, extinct. The same remark is of course applicable to the bones of the hog and the wild boar, found occasionally among other fossil remains.

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[*] Or Mastodonte, which is sometimes, but unnecessarily, rendered by Mastodonton: *μαστος*, mamilla.

[†] Five more species have since been discovered.

The tapir family in many important particulars resembles the rhinoceros; and those are often found *in the same* tertiary strata with the rhinoceros, elephant, and mastodon, several species now wholly extinct, but allied to the tapir. Two of these must have been of prodigious size, the largest 18 feet (19¼ English) long and 11 (nearly 12 English) high.* But there are other species, to the number of twelve at least, whose size differs little from that of the tapir; the bones are somewhat different, however, and particularly the teeth, which, from the eminences or ridges upon them, Cuvier made the ground of the genus, to which he gave the name of *Lophiodon*.† It is in different parts of France that all these species were first found: the smaller ones always in strata of fresh-water shells, and in company with remains of either unknown land animals, or crocodiles and other river animals now found in hot climates; and in several places the strata in which they occur, have been covered over, after they had been deposited and their bed consolidated, with strata of an origin unquestionably marine. By far the greater part of fossil remains, both those which have been already described, and those which we are afterwards to consider, having been found in sandy, or calcareous, or other earthy strata. But some few are also found in imperfect coal or lignite. In the part of the Appenines where that range meets the Alps there is a tertiary coal stratum, and in it have been found two new genera of pachydermatous animals, and a third in the fresh-water deposit near Agen. Cuvier calls these *Anthracotheria*.‡

The general conclusion which is to be derived from the important branch of the inquiry of which we have been analyzing the resulting propositions, is partly zoological and partly appertains to geology. The former portion of it is, that more than thirty kinds of land animals have left their fossil remains in the strata now forming dry land, but deposited under water; that of these, seventeen or eighteen* are now extinct, and have been wholly unknown since the earth was peopled with its present inhabitants, six or seven being of a genus now unknown, the others being new species of known genera; that twelve or thirteen kinds have, as far as their bones are concerned, the appearance of having belonged to the species which still inhabit the globe, although their identity is far from certain, depending only upon the similarity of their skeletons; and that animals of genera now almost confined to the torrid zone used formerly to inhabit high and middling latitudes. The geological portion of the conclusion is that some of these fossil remains have been buried by the last or one of the last revolutions to which our planet has been subjected, as they are in loose and superficial strata, whilst other remains in the tertiary strata appear generally to have come from deaths in the course of nature, though some of these too must have perished by a sudden revolution.

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* This is now better known, and is called the *Dinotherium*.

† *Λοφιον*, a small hill, eminence, or ridge

‡ *Ανθραξ*, coal. Of these seven species are now known.

II. The Paris Basin presents, in great abundance, the remains of herbivorous pachydermatous animals of two distinct genera, each comprehending several species, and all alike unknown in the living world. The animals to which some of them approach the nearest are the tapirs; but they differ even generically from these, and from every other known tribe. The inquiry into which Cuvier entered for

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* According as the Elasmotherium is allowed to be sufficiently distinguished or not.

e purpose of ascertaining to which set of bones
ach particular piece belonged, so that he might
e able to restore the entire skeletons by putting
gether all the parts of each, was long, painful,
nd difficult in the highest degree. He had first to
onnect the two bones of the hinder feet together,
n each instance, by minutely examining the relation
f the pieces to one another; and this process could
nly be conducted by deriving light from the analo-
ies of other and known animals. He then had the
ifferent bones of the fore feet in like manner to put
gether, in order to restore those fore feet. Next
he hinder and fore feet of each animal were to be
onnected together. Afterwards he had to mount
pwards and connect the bones of the body with
e several feet. The teeth and head must next be
eferred to the limbs. Then the vertebræ and then
he trunks were to be restored; and then other
ones, not yet accounted for, were to have their
laces found. The result of this most elaborate
nd perplexing investigation, the details of which
ccupy the fifth part of a large quarto volume, and
re illustrated by between sixty and seventy admi-
able plates, containing between six hundred and
even hundred figures of bones, fragments of bones,
nd congeries of bones, may be stated shortly
hus:—There are of the first genus, which he de-
ominates *Palæotherium,*[*] six, or perhaps seven,
pecies[†] principally distinguished by the teeth and
he size, as far as the bones are concerned, but
vhich, probably, were much more widely different
vhen alive. One of these resembled a tapir, but
vas only a foot and a half in length, being about

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[*] Παλαιος, ancient; θηριον, wild beast.

[†] Eleven species are now known.

the size of a roebuck. Another was nearly three feet high, and the size of a hog. A third was between four and five feet in height, and about the size of the horse or the Java rhinoceros. It had feet thicker than a horse's, and a larger head; its eyes were very small, its head long, and it had a snout protruding much over its under jaw and lip. In a specimen of one of these species, the first now mentioned, there were actually found some of the animal's softer parts, certain flexible filaments, which, upon being burnt, gave an animal smell, and were manifestly portions of the nerves or blood-vessels. Besides these three species, three, and possibly four others, were distinguished, one the size of a hare.

The other genus was termed by Cuvier *Anoplotherium*,* and of these, two species, at least, are distinguishable.† The first, or *common* anoplotherium, is about the size of an ass, being four or five feet high, and its body four feet long, but with a tail of three feet long; it was probably an animal that lived partly in the water, as it appears made for swimming like an otter. But it has a peculiarity of structure which is to be found in no other animal whatever; its feet are cloven, but have two separate and distinct metacarpal and metatarsal bones, which are soldered together in other animals; it has also its teeth contiguous, while all other animals except man have them apart. The other species, or *secondary* anoplotherium, resembles the former, but is only the size of a common hog. But beside these anoplotheria properly so called, four other cognate species are found, one of the size and ppearance of a gazelle, one the size of a hare, and wo of the size of a guinea pig. A curious specinen gives the very form of the anoplotherium's rain, a cast of it remaining in the earthy mass. Its size is extremely small, and Cuvier infers from his that the animal was exceedingly stupid.

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*Ανοπλος, unarmed, without tusks.

† Six species are now ascertained.

All these animals are found in the Paris Basin; ut bones of the palæotherium have been discovered lsewhere, namely, at Orleans, Aix in Provence, Montpelier, and Isell. As the specimens from those ther places were extremely rare in Cuvier's time, e could not have the same certainty respecting hem as from the more copious collections obtained n the Paris district. But he could distinguish at east three different species.

Beside these two new genera, the palæotherium nd anoplotherium, the Paris Basin affords two ther new genera of pachydermata, the one, called *Chæropotamas*,* resembling animals of the hog ind—the other, *adapis*, very small, being about a hird larger than the hedgehog, which it also reembled in structure. There are found, too, the emains of five or six kinds of carnivorous animals, ne of them being of enormous size, and resemling a tiger. Another has projecting bones to upport a bag or purse as in the kangaroo kind; ut it is of a genus of marsupial animals now ound only in America, being a sort of opossum. The Basin, besides, affords a considerable number f tortoise remains, some fish bones, and even perectly complete skeletons of fish, and ten species, t least, of birds, all now unknown, but one of vhich resembles the Egyptian ibis. It is very renarkable that in one specimen, brought to Cuvier while his work was printing, the windpipe was preserved, and the mark or mould of the brain appeared upon the surface of the gypsum.

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* There are now three species known.

III. Of ruminating animals the fossil deposits present many remains. There are of the deer, beside divers that closely resemble known species, no less than twelve* species wholly unknown among the existing inhabitants of our earth. One has enormous horns, six feet from tip to tip, and of this animal we know nothing among existing species, though it comes nearest the elk. Two kinds are somewhat like roebucks, and of that size. The fissures of the Mediterranean give six new species,† of which that found at Nice is like an antelope or sheep.‡

None of our common oxen are found in a fossil state, unless in morasses or peat bogs, where they have certainly been buried while the globe's surface was in its present condition, and peopled as we now find it. But animals of the same genus certainly existed in the age of the elephant and rhinoceros, and of the extinct species.§ There prevails no small uncertainty as to the identity of the ssil bison and musk buffalo with the living ecies of the former in Europe and of the latter in merica; but the remains which have been found a kind of ox, appear different from any known ecies, and it appears that no buffalo resembling ther that of the East Indies or that of the Cape as been found in any place.

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* No less than twenty-eight species are now known.

† In the Résumé to Parts III. and IV., Cuvier says, "Of the six deer found in alluvial deposits, one with large horns is entirely unknown; of the four in fissures, three are unknown, at least in any but most distant countries. Another, that of Orleans, is quite unknown, as are the two species of lagomys found in the fissures."

‡ A thirteenth new species was at one time supposed to have been found in the Swedish province of Scania; but Cuvier, before the last volume of his work was printed, had reason to believe that this animal belonged to one of the tribes formerly known, and still living in the north of Europe.

§ Of these there are now seven ascertained.

The conclusions, both zoological and geological, om this part of the investigation and from the amination of the remains found in the Paris asin, in every respect tally with those to which we ere led by a consideration of the pachydermatous mains under the first head of the inquiry.

IV. There are found in caverns both in France, ermany, Yorkshire, and Devonshire, and in the esh-water formation of Val d'Arno, in Tuscany, e remains of many animals, some extinct and thers no longer inhabitants of the same temperate titudes, but confined to the frozen and the torrid ones. By far the greater part of these animals elong to the carnivorous class, except in the Yorkire caves, where many of the herbivorous kind are lso to be found. In the foreign caves the bear is e most numerous, and presents extinct species. n the Yorkshire caves (at Kirkdale) the hyæna redominates. In the German caves hyænas are omparatively few, and in Val d'Arno not more umerous. In Kirkdale there are very few bears. he race of lions and tigers is much more rare than ny of the others. Not above fifteen have been ound in Germany, while there have been found undreds of bears; and in Yorkshire, where hyænas bound, very few lions and tigers are traccable. Of e wolf and fox, some are found, but not so many Yorkshire. There is also a very large kind of dog traced, which must have been five feet in height and eight in length from the mouth to the tail.

Of bears it appear, after a very close examination, that there are found, at least two species* larger than those now known, and a third which, both in size and other particulars, so nearly approaches the common bear, that Cuvier does not regard it as a new species. But it seems as if the one found in Tuscany formed a third kind of animal now extinct.

The hyæna† is found not only in the caverns and other quarries where the bear abounds, but also in the alluvial strata with the elephants and rhinoceroses. In Kirkdale cave his dung has been distinctly recognised by a comparison with that of living hyænas; and the particular crack which he makes in the bones of the beasts devoured by him to get at the marrow, has, in like manner, been identified by actual comparison. Nevertheless the fossil animal differs from the living one in some material respects, particularly in size, and in having his extremities both thicker and shorter. The caverns contain two species‡ of a huge animal of the felis (or cat) kind, considerably larger than the lion or the tiger, beside some few resembling living species in size. One is between one-eighth and one-ninth larger than the lion, and has its trunk more convex in the lower outline. A new, but smaller, species of the felis kind is also found in the Mediterranean fissures.

In the dog tribe there has been found a wolf or dog,§ but more probably the former, which differs, hough slightly, from any known species, in having he muzzle shorter in proportion to the skull ; and also a species has been observed clearly new of the same genus. We as yet only know of it by two of his jaw teeth, found at Avaray, near Beaugency. He must have been eight feet long and five high. The Paris Basin affords, likewise, another new species of the dog kind, but not materially varying in point of stature. The common fox, however, is found, and also the dog and wolf, in the caves.

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* Seven more have since been added.

† Now eight species.

‡ Now fifteen.

§ Ten species are now known.

The caves afford a considerable number of bones of the weasel and glutton,* closely resembling the existing species. The latter animal is only known now in the higher latitudes; but in the caves we find his remains mixed with those of animals belonging to the temperate and the torrid zones.

It is thus shown by the inquiries which comprise the third and fourth part of this great work, that the former inhabitants of these regions were wholly different from the present population. Even the animals of hot climates here found, and referable to existing genera, must have differed entirely from those species which survive in the torrid zone, because they could exist in a temperature now wholly foreign to their nature. The rein-deer and the lion, the sloth and the elephant, all found in the same places, show that the climate of those latitudes remains nearly the same, but that their inhabitants have been changed.

In all these researches one blank is immediately perceptible. There are not only no human remains whatever, but there are none of apes or of any of the genus of quadrumanes. Animals far less in ize, and whose bones would much more easily have perished, as rats and mice, have left their skeletons with those of the largest beasts; but of the monkey tribe no vestige whatever is to be discovered; and the conclusion is inevitable, that the strata were deposited, the fissures filled, the caverns strewed with bones, at an age anterior to the existence of that tribe, as well as to the creation of our own species. Thus it was when Cuvier wrote.*

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* Of the fossil gulo two species are now ascertained.

V. Beside the animals of the *Rodent* description found in the Paris Basin and the Mediterranean fissures, rabbits, lagomys, field mice, there are several others in the alluvial strata and caverns,—some apparently of known, and others certainly of unknown kinds. The hare has been traced at Kirkdale; the beaver near the Rhine; two new species† of the beaver near Rostoff, in the south of Russia; another species, also unknown, at Œningen.

VI. The toothless or *Edentate* animals afford some varieties still greater than those to which our attention has as yet been directed. None of the known species of this tribe are to be found in any of the strata, fissures, or caves in Europe. But three genera entirely new, with two of which at least there are ample materials for becoming acquainted, have been found in America, and these are deserving of our best attention.

The first is the animal named by Jefferson, from the size of his feet, or rather what he supposed claws, the *Megalonyx*,‡ and respecting which he fell into an error as we formerly stated. Cuvier preceded his examination of this as of all other animal remains by a thorough investigation of the osteology of living animals of this family; and it is the result of his careful enquiry that the bones found in America and described by Jefferson, and of which both casts and drawings were sent over, as well as a tooth, belonged to an animal of the sloth tribe, but wholly new, and now quite extinct. The tooth was cylindrical, and worn down on the top, but cased round with enamel like a sloth's, and not at all like a cat's. In the paw, the second phalangal bone was symmetrical. This bone is curved and not symmetrical in animals that raise up and draw back the claw, as all the cat kind do. The first phalangal bone, too, was the shortest; whereas the lion and others of the cat kind have that bone the longest. But from the known species of sloth it differs most strikingly in its stature, which was equal to that of the largest oxen, those of Hungary and Switzerland, and a sixth larger than the common kind.

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* This refers of course to the state of discovery in Cuvier's time. There are remains of the monkey said to have been lately discovered in the South of France and in the Himalaya Mountains; it is said also at Calcutta. But the proofs are not clear.

† Now four are known, and three of lagomys.

‡ Two species are now known.

The second of these new animals has been termed *Megatherium*, from his great size, and the remains are found in South America. From his teeth it appears that he lived on vegetables, but the structure of his very long fore paws and nails shows that it was chiefly on the roots. He possessed also good means of defence, and so was not swift of foot. His covering seems to have been a thick and bony coat of mail like the armadillo's. His length was twelve feet and a half (near thirteen feet and a half English), and his height seven feet (about seven feet and a half). From the sloth he differs not only in size but in other particulars; for example, his fore legs are much nearer the length of his hinder legs than in the sloth, which has the former double the latter. But, on the other hand, the thickness of the thigh bone in the megatherium is much greater than in any of the known sloth tribe, or indeed any other animal either known or extinct; for the thigh bone is about half as thick as it is long.

The third of these new animals was known to Cuvier only by one fragment which he examined. It was a toe; and from a careful discussion of its form and size he inferred that the animal belonged to the edentate tribe of Pangolins, and that, if so, its length must have been twenty-four feet (twenty-six English), and its height in the same enormous proportion. The bones were found in the Palatinate near Eppelsheim.*

VII. The course of our analysis has now brought us to the family of the *Sea Mammalia*, and these supply new food for wonder. So different from the bones of any living animals are those remains which have been examined, that a new genus is formed consisting of several species, and bearing the same relation to the cetacea, or animals of the whale tribe, that the mastodon, palæotherium, and anoplotherium do to the pachydermata, or that the megalonyx and megatherium do to the edentata. He terms the genus *Ziphius*, from its having a sword-like head. One of these was found near the mouths of the Rhone. The dimensions are not given by Cuvier, but from the drawing the head appears to have been about three feet in length. The remains of a second species of ziphius were found thirty feet under round at Antwerp, and between nine and ten nder the level of the sea at low water. The head s considerably larger than that of the first menioned species. The head of a third species is found n the museum at Paris, but with no account of its istory.

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* Subsequent discoveries have made it probable that this toe belonged to the Dinotherium.

Besides this new genus, there are other cetacea f new species discovered among the fossil bones. At Angers a Lamantin of an extinct species has een traced. The remains of a dolphin, which nust have been twelve or thirteen feet long, and ifferent from all the known species, have been ound in Lombardy. In the Landes another dolhin, which must have been nine or ten feet in ength, has been discovered. A third kind of dolhin, different from any now living, has been found n the department of L'Orne, while a fourth, also ound in the Landes, nearly if not wholly resembles he ordinary dolphin. In Provence a cetaceous nimal of an unknown species is found, somewhat ke the hyperodons.

In the neighbourhood of the Ochil hills in Scotand the fragments of a whale's bones have been ound in a recent alluvial stratum, at only eighteen nches' depth, with a part of a deer's horn near. t must have been a whale of some size, as the verebræ were eighteen inches broad, and one of the ibs ten feet long. But it is most probably one of kind still existing in our seas, from the place here it was found.

In the mountains near Piacenza there have been ound the bones of a small whale. Its length was wenty-one feet (near twenty-three of ours) and its ead was six feet (near six feet and a half) long. he place where these bones lay was a clay stratum with numberless shells all round, and oysters clinging to the bones. This animal was in a tertiary formation, six hundred feet above the plain of Italy. It appears to be of a new species.

In the very heart of the city of Paris have been found the bones of another whale, far larger, and of a species wholly unknown. Its head must have been fifteen or sixteen feet long, and its body fifty-four or fifty-five. It was found in a compact sandy bed in digging under the cellar of a wine-merchant.

The conclusion to which these Researches unavoidably lead is that the earth in its former state did not differ more widely in the races which inhabited it than the sea did—that ocean which was itself the great agent in producing many of the changes that have at various times swept away one race of living creatures from the surface of the globe, and mixed up their remains with those of animals engendered in its own bosom.

VIII. We have now reached the last and the most singular portion of these Researches; the examination of *Reptiles* whose relics are found in many of the stratified rocks of high antiquity.

In the calcareous schist, near Monheim, whence the stones used in lithography are gotten, a new species in the crocodile family is found, whose length must have been about three feet. At Boll, in Wirtemberg, another, apparently of the same kind, has been discovered. At Caen oolite quarries, a different and equally unknown species is traced; its body is between four and five feet long, and its whole length thirteen. Others of this family have been found in the Jura, and there they are accompanied by the fresh-water tortoise. At Honfleur another species is found, and the remains of two other unknown kinds have been discovered near Harfleur and Havre.

Beside the remains of crocodile animals found in these more ancient strata, there are many also found in the more recent beds, where the bones of the palæotheria and lophiodons are deposited. The Paris Basin, the marl pits of Argenton, Brentford, and other places have furnished these specimens. But whether they were of different species from those new ones found at Monheim, Caen, and Honfleur, the examination which they had undergone in Cuvier's time was too imperfect to determine. They have since been shown to be different.

It deserves to be remarked of the new species of crocodiles, that their difference from the known kinds exceeds in manifest distinctness that of almost any other animals which are of the same genus, and do not differ in size; for the vertebræ, instead of being, as they are in the crocodiles now alive, concave in the front and convex behind, are convex in front and concave behind. This at once furnishes a very triumphant answer to those doubts which have been raised as to the novelty of the species, and still more signally discomfits the speculations of those who fancy that the difference perceived in fossil bones has been caused by change of temperature or of diet, or by the passing from the living to the petrified state.

The examination of fresh-water tortoises, of the genus trionix, whose remains are found in the plaster quarries and other strata, offers similar results. Thus at Aix in Provence a trionix of a new species is found. Another species, also new, is found in the Gironde; and two others have been traced less distinctly in the gravel beds of Hautevigne (Lot et Garonne) and of Castelnaudary.*

Fossil fresh-water tortoises, of the genus emys, give the same results. They are found in the molasse of Switzerland, in the Sheppy clay near London, and in the limestone ridges of the Jura.

Fossil sea tortoises offer the like appearances. One of an unknown species is found near Maestricht, the genus being still living in the sea, and familiar to our observation. So that altogether the examination of tortoise remains leads to the same inferences of islands having existed in the ocean at a former period, inhabited chiefly by reptiles or oviparous quadrupeds, and before the creation of any considerable number of the viviparous orders.

As we proceed towards the close of these Researches the subject rises rather than falls off in curiosity and interest. We now come to the family of lizards, by which is here understood all the old genus of Lacerta (Lin.), excepting the crocodile and salamander tribes.

In the celebrated fossil fish deposits of Thuringia are found the remains of a monitor, of a species somewhat varying from the known species in two particulars, a greater elevation of the vertebral apophyses, and a longer leg in proportion to the thigh and foot. Remains of a similar aspect occur in France near Autun, and in Connecticut in North America.

In the strata of fine and granular chalk near Maestricht, between 400 and 500 feet in thickness, are found the remains of a huge reptile, which Mr. Faujas represented as a crocodile, following the opinions of the people in that neighbourhood; but so celebrated an anatomist as Adrian Camper was not to be thus deceived, and he proved it to be an animal of a new genus, related to the monitor, and also to the iguana; it seems to be placed between the fishes on the one hand and the monitors and iguanas on the other. But the size constitutes its most remarkable difference when compared with these. They have heads five or six inches long; his was four or five feet, and his body fifty. He was therefore a lizard exceeding the size of a crocodile; just as the extinct tapir was the size of an elephant, and the megalonyx was a sloth the size of a rhinoceros. It appears that, like the crocodile, he was aquatic and could swim; and that his tail was used as a scull, moving laterally in the water, and not up and down like the cetacea, an order to which the elder Camper at first rashly referred him.

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* Eight species have now been traced.

In the canton of Meulenthal, at Monheim, ten feet below the surface, and near some kinds of crocodile remains, bones were discovered of another unknown sub-genus of the order Saurus, and which Cuvier calls Geosaurus, and places between the crocodile and the monitor. It was apparently twelve or thirteen feet long, that of Maestricht being fifty.

A large animal of this family is found to have been an inhabitant of the same ancient world. At Stonesfield, in the neighbourhood of Oxford, Dr. Buckland discovered his remains in a bed of oolitic calcareous schistus under a solid rock of forty feet thick. The thigh bone is two feet eight inches in length, which would seem to indicate a body in the whole forty-five feet long. But even if his tail were not in the proportion of the lizard's, as this calculation assumes, his length must be, according to the crocodile's proportions, thirty feet. This animal approaches the geosaurus of Monheim, and also, in other respects, has some affinity with the crocodile and monitor; but in size he greatly exceeds the crocodile, and comes nearer the whale. His voracity must, from his teeth and jaws, have been extreme. He was also an amphibious animal; for his remains are surrounded with marine productions. The genus has been called *Megalo-saurus*. Teeth and bones of the same genus have been since discovered in Tilgate Forest, Sussex. Mr. Mantel has found in the same place the thigh bone of a much larger animal. Other reptiles have been found in the Muschelkalk quarries near Luneville.

But there are animals of the family of saurus yet more strange, if not for their size, at least for their anomalous structure and habits. A reptile is found of a genus so extraordinary as to comprehend within itself the distinguishing nature both of the lizard and the bird. It has a very long neck, and the beak of a bird. It has not, however, like a bird, wings without fingers to strengthen them; nor has it wings in which the thumb alone is free like a bat; but the wings spread by a single long finger, while the other fingers are short, and with nails like the fingers of ordinary apterous (or unwinged) animals. From these circumstances Cuvier has named this genus* the *Pterodactylus*.† It was first discovered by the late Mr. Collini, a Florentine, settled at Manheim, and formerly attached to the family of Voltaire, of whom he published some memoirs. The skeleton, nearly perfect, was found in the marly stone beds of

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* There are now ten species observed.

† Πτερον, wing; δακτυλος, finger.

Aichstadt in the county of Pappenheim; but Mr. Collini fell into very great mistakes respecting the genus of the animal, which he supposed to be of marine origin, from not accurately investigating its osteology. The celebrated Sœmmering contended that it was one of the mammalia, resembling a bat, and other naturalists held the same opinion. But Cuvier has most satisfactorily shown, chiefly from its jaws and vertebræ, its shoulder-blade and sternum, that it is between a bird and a reptile, a flying reptile. The tail is extremely short, and this indicates the animal to have used its wings chiefly for locomotion: indeed, from its very long neck, it must have had great difficulty in either walking or crawling. When at rest, it must have stood like a bird on its hind legs, and also, like some birds, have bent back its long neck in order to support its very large and heavy head. Another species of the same genus, having a much shorter beak (for that of the former is longer than the whole body), has also been found near the same spot. It is much smaller. Very scanty remains of a third species also occur, found in the same quarries. Its size must have been nearly four times greater than that of the kind first mentioned, and it must have presented one of the most monstrous appearances which can be conceived, according to our present experience of animal nature.

The two last discoveries among the animals of a former world, which these researches have disclosed, remain to be mentioned; and they are, in the eyes of the naturalist, the most wonderful of the whole, although to an unlettered observer they may appear less strange than the tribe we have just been surveying. One of them has the muzzle of a dolphin, the teeth of a crocodile, the head and breast of a lizard, the fins or paddles of a whale, but four instead of two, and the back or vertebræ of a fish. This has been named the *Ichthyosaurus*. The other, being apparently nearer to the lizard, has been called the *Plesiosaurus*;[*] and has also four paddles like those of a whale; the head of a lizard, and a long neck like that of a serpent. Both are found in the older secondary strata of the globe; in the limestone marl or greyish-lias, filled with pyrites and ammonites, and in the oolite beds of the formation called Jurassic. They are both chiefly found in England, and were first discovered there.

Sir E. Home, in 1814, made the first step in the discovery of the Ichthyosaurus; having obtained some bones found on the Dorsetshire coast, thirty or forty feet above the level of the sea. He gradually obtained more of these remains, until 1819-20, when the discovery was completed. But he seems to have been unfixed and variable in his opinion respecting the animal; and after believing for some time that it was partly a fish, he ended by believing it to be no such thing, and changed its name from ichthyosaurus, which Mr. König had given it, as early as 1814, to *Proteosaurus*, supposing it to have some affinity with the proteus as well as the lizard.

The ichthyosaurus is most abundant in the lias strata in the lower region of the Jura formation. Its remains are not confined to Dorsetshire; they are found in Oxfordshire, Somersetshire, Warwickshire, and Yorkshire. But at Lyme they abound as much as those of the palæotherium do in the pits of Montmartre at Paris. Some few specimens are found near Honfleur and at Altorf; in Wirtemberg, also, a nearly complete skeleton has been discovered. Four* distinct species were ascertained by Cuvier, chiefly differing from one another by their teeth, that is to say, as far as their osteology goes.† In the general features of their bones they all approximate to one another. The head resembles that of the lizard, although with material differences, and even having some other bones. The eyes are extremely large, differing in this from all the greater animals both sea and land. The cavity in some specimens is above a foot in diameter. Each eye is protected by a shield of bone, composed of several pieces knitted together. The vertebræ are very numerous. In some specimens as many as ninety-five are to be seen; and these differ entirely from the vertebral system of the lizard, resembling rather that of fishes, for they are flat like backgammon, and concave on both sides. The animal has four fins, or paddles, each composed of six rows of small bones, nearly one hundred in all, and so fitting into one another, that he could paddle about by means of them, moving with more elasticity than if the bones had formed a single piece. The teeth are sharp. This creature could only breathe the air, and so must often have come up to the surface. Yet, again, he could only move in the water, and was still less able to crawl on land than even the sea-calf. The length, in some cases, reaches to twenty-four or twenty-five feet. In the strata where these bones are found there are many of the cornu ammonis and other marine shells, and remains of crocodiles exist in the same strata.

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[*] Πλησιος, near

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* Four species have since been added to these.

† It cannot be too steadily kept in mind that when a specific difference has once been ascertained, so as to distinguish one of these extinct races from another, the amount of that difference is no measure at all of the diversity which may have existed between the two animals. Tribes the most unlike have general resemblances in the bones, the substratum on which the muscular parts are placed. Witness the ease with which unlearned persons, nay, even naturalists carelessly observing, have taken the skeletons of lizards for those of men.

The plesiosaurus was first observed in 1821, by Mr. Conybeare and Mr. Delabeche; and in Cuvier's time its remains had only been found in England, unless those discovered at Honfleur belong to this genus. The discovery was fully made in 1824. The distinguishing feature, the long neck, has many more vertebræ than even a swan's. In the fine specimen from Lyme there are in all eighty-seven vertebræ, of which thirty-five belong to the neck and twenty-five to the tail. The vertebræ, though their axis is very short, resemble the crocodile's more than the lizard's. The teeth are pointed and slender. The paddles consist of many bones, in rows like those of the ichthyosaurus; but they taper more, consist of fewer pieces, not above fifty, and are longer than those of the ichthyosaurus, nor do they form a kind of pavement like his. Five species* of this animal were distinguished by Cuvier. That found at Lyme appears to have been seven or eight feet long; but other species, from one jaw bone which has been discovered, must have reached the length of twenty-eight feet.

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* Three have since been added.

The eighth and last part of these Researches which we have just surveyed, is remarkable, as regards the skill and diligence of the illustrious author, for two particulars. *First*, the extraordinary success of his indefatigable investigation from very scanty materials derives especial attention. In some cases he had only one or two bones to examine and to reason from. In others he had a far greater number; sometimes he had the whole skeleton in scattered parts; in a few instances the whole together in their natural juxtaposition and connexion. But he found where he had many bones, that from a single one, or from two, he could have reached the very same conclusions which the examination of the whole led him to. This was observable in a very remarkable manner when he investigated the mosasaurus, or saurus found at Maestricht. He had not examined more than the jaw bone and the teeth when he knew the whole animal; but he says that a single tooth discovered it to him: he had got the key; after that every other part fell in at once of itself into its proper place. *Secondly;* Although he was not the discoverer of either the ichthyosaurus or plesiosaurus, and had to tread on ground which his eminent and able predecessors had gone over, his researches even here were quite original. He collected all the evidence, whether by drawings, descriptions, or models, of what had been before them; but he also enlarged his collection of facts by numberless specimens both of the same kind which they had examined and of different kinds never submitted to their view. He investigated the whole as if the field had been still untrodden and the soil yet virgin; and accordingly his work, even in this subordinate branch, is far from being a repetition; his inquiries far from being a mere reiteration of theirs. Where he does not vary or extend the results at which they had arrived, he carefully confirms their propositions, and ascertains the truth of their learned conjectures; so that he adds to the precious monuments of his predecessors, by either enlarging the superstructure or strengthening the foundation.

That such a guide to our inquiries is worthy of all confidence, no one can doubt. That even his authority, the weight of his opinion, is very great would be a proposition as indisputably true, if in matters of science it were lawful for the learned to pay any deference to mere authority; yet even here ignorant men may bow to him, and receive his doctrine with a respect which they might be justified in withholding from others. But his system makes no such appeal, and requires not to be received upon terms like these. He has given us without any reserve every particular which his whole researches presented to his own view, and preferring the risk of being tediously minute to the chance of leaving any point unexplained, or any position without its needful proof, there is not a fragment of bone which he has ever examined, and on which he raises any portion of his philosophy, that he has not both described with the fulness of anatomical demonstration, and offered to the eye of his reader in the transcript of accurate and luminous engraving. His work is accompanied with between forty and fifty maps and sections of strata, above 250 plates representing upwards of 3800 skeletons, bones, teeth, and fragments. *These are* all presented to the examination of the expert, in their connexion with the author's description both of what the diagrams can, and of what they cannot, fully represent. But they are also presented to the uninformed, who can, by attentively considering them, institute a comparison between the structure of known and living animals, and those of which the earth's strata contain only the remains. Giving Cuvier only credit for having correctly written down what he observed, and accurately represented in his figures the subjects of his examination, we are enabled to see the whole ground of his reasoning: we can mark the points in which a fossil animal resembles a living one, and those in which the two differ; and we have even a higher degree of evidence in behalf of the author's conclusions than we have in reading Sir Isaac Newton's experiments upon light, because every thing in this case depends upon configuration, which a drawing can accurately represent, whereas much in the optical case must needs turn upon appearances observed by the experimenter, and which no drawing can convey to our apprehension.

If again we compare the certainty and fulness of the proof in this case with that which we have in examining any anatomical proposition, or any doctrine of natural history, whether of animals or of plants, we shall still find it of a separate and higher kind. For in those branches of science much more is necessarily left to description. The question here is always one purely osteological as regards the animals; and osteology is of all branches of anatomy, whether human or comparative, the one where most depends upon mere figure, and where of consequence the reader can approach most nearly to the observer in weighing the proofs on which his demonstration rests. The geological matter bears but a small proportion to the zoological in these inquiries. It is indeed of the highest importance; but it is incapable of much doubt, and admits of no mistake or imposition—for the strata where the different animal remains have been found are well known, and, in the very great majority of cases, are of easy access to all. The sciences of geology and mineralogy are sufficiently certain, at least for the main purposes of the inquiry; the names and description of the beds of the globe's surface are the portions of those sciences upon which no doubt or difficulty can exist; and the great body of Cuvier's results remains unaffected by any differences of opinion upon speculative geology.

Thus the comparison stands as to the degree in which the evidence is made plain to the reader of Cuvier's researches, and the reader of other records of discovery in the inductive sciences. But let us extend our view a little further, and compare the proofs before us in these volumes with those reasonings upon which the assent of mankind has been given, and is continued unhesitatingly, to the great truths of the mixed mathematical sciences. The reader of the "*Principia*," if he be a tolerably good mathematician,* can follow the whole chain of demonstration by which the universality of gravitation is deduced from the fact that it is a power acting inversely as the square of the distance to the centre of attraction. Satisfying himself of the laws which regulate the motion of bodies in trajectories around given centres, he can convince himself of the sublime truths unfolded in that immortal work, and must yield his assent to this position, that the moon is deflected from the tangent of her orbit round the earth by the same force by which the satellites of Jupiter are deflected from the tangent of theirs, the very same force which makes a stone unsupported fall to the ground. The reader of the "*Mécanique Celeste*," if he be a still more learned mathematician, and versed in the modern improvements of the calculus which Newton discovered, can follow the chain of demonstration by which the wonderful provision made for the stability of the universe is deduced from the fact that the direction of all the planetary motions is the same, the eccentricity of their orbits small, and the angle formed by the plane of their ecliptic acute. Satisfying himself of the laws which regulate the mutual actions of those bodies, he can convince himself of a truth yet more sublime than Newton's discovery though flowing from it, and must yield his assent to the marvellous position that all the irregularities occasioned in the system of the universe, by the mutual attraction of its members, are periodical, and subject to an eternal law which prevents them from ever exceeding a stated amount, and secures through all time the balanced structure of a universe composed of bodies, whose mighty bulk and prodigious swiftness of motion mock the utmost efforts of the human imagination. All these truths are to the skilful mathematician as thoroughly known, and their evidence is as clear as the simplest proposition in arithmetic is to common understandings. But how few are there who thus knew and comprehend them! Of all the millions that thoroughly believe those truths, certainly not a thousand individuals are capable of following even any considerable portion of the demonstrations upon which they rest, and probably not a hundred now living have ever gone through the whole steps of those demonstrations. How different is the case of the propositions discussed by Cuvier and his predecessors! How much more accessible are the proofs on which their doctrines repose! How vastly more easy is a thorough acquaintance with the "*Recherches*" than with the "*Principia*" and the "*Mécanique Céleste!*" How much more numerous are they who have as good reason for fully believing the propositions, because as great facility of thoroughly examining the proofs, as first rate mathematicians can have for assenting to Newton's third book, and La Place's great theorem, or as common readers have for admitting any of the most simple truths in the easiest of the sciences!

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* It is the object of the Analytical View of that great work in this volume to make the demonstration, the proof on which the Newtonian system rests, so easy as to be followed by persons little skilled in mathematical science; but the remarks in the text will, it is to be feared, always remain well founded. The like may still more be said of the *Analysis* of La Place's Mécanique Céleste.

The extraordinary truths unfolded by the "*Recherches*" we have had an opportunity of stating in detail. But it is necessary to revert to some of the more general conclusions in their more immediate connexion with the great subject of these volumes. The Illustration derived to theological inquiry from the powers of inductive investigation in this branch of science, and the Analogy found between the two kinds of demonstration, was stated in the Introductory Discourse; but these form by no means the whole contribution which this new branch of knowledge furnishes to Natural Religion. Before the nature and extent of that aid could be understood, it was necessary that the details of the science itself should be considered, and its general principles unfolded, together with the grounds upon which they rest. We are now more particularly to make the application.

To the geologist, as Cuvier has well observed, the vast periods of time over which the phenomena that form the subject matter of his inquiries have extended, offer the same kind of obstruction as the astronomer finds from the immense space over which his researches stretch. The distance of time is to the one as great a difficulty as that of space is to the other in prosecuting his researches. Yet as the properties of light, and its relation to media artificial or natural, furnish a help to the senses of the astronomer, so the endurable nature of the principal portions that compose the framework of animal bodies give invaluable assistance to the labours of the geologist and anatomist, supplying records which it is as physically impossible he should have in any history of past changes on the globe, as it is that the naked eye of the astronomical observer should penetrate into boundless space. The most minute bones of small animals, even their cartilaginous parts, and the most delicate shells of sea or river fishes, are found in perfect preservation. These shells are found, too, on ground now and for ages lying high above the level of any waters, in the middle of the hardest rocks, reaching the summits of lofty mountains, lying in vast layers of a regular form and solid consistency, and which seem to demonstrate the proposition that the sea in former ages was spread over the regions where those strata were formed, and lay there long and quietly. The level parts of the earth, which to an observer who only regards its surface seems always to have been in its present state, can hardly be penetrated in any place without showing that it has undergone such revolutions and been under the sea for ages; while the bottom of the ocean has at those remote periods been dry land. But when we ascend to geater heights, we find the same proofs of former changes; marine remains often show themselves on Alpine summits, but their kinds vary much from those of the lower regions; they are exposed to view by the layers in which they lie imbedded being no longer horizontal and buried deep under ground, but nearly vertical, broken in pieces, and thrown variously about. These strata have for the most part been of a formation long prior to that of the horizontal ones, and were at one time displaced, and elevated and rolled about; the ocean was the great agent in their formation as in that of the strata which it afterwards deposited horizontally around them; the ocean, too, was the agent which, after having first deposited, afterwards dislocated and raised them into rocks, promontories, and islands, amidst which the strata still found horizontal were laid.

This ocean, at different times, not only held in solution different dead matter, but was inhabited by animals of kinds that exist no more. When it last left the earth and retreated into its present position, the only one in which we have ever known it by actual observation, its inhabitants nearly resembled those which still live and swarm in its waters. But at more remote periods, and when forming its more ancient deposits, it was the receptacle of animals of which not a living trace now remains; animals all whose species are extinct;

animals of genera absolutely different from any now known, and which sometimes united together in one individual frame, parts now only found separate in distant and unconnected tribes.

Again, the intermixture of land animals and of fish the inhabitants of fresh water only, with those of marine origin, shows that several successive irruptions of the ocean must have taken place, and that after it remained covering the land during successive periods, it retreated successively, and left that portion of the globe dry. Nor can there be any doubt that large portions of the earth now uncovered and inhabited by the human species and other tribes of living animals had, before it was last covered by the sea, been dry, and been inhabited by a race of animals of which their fossil remains are all that we can now trace.

It is probable, too, that many of these mighty revolutions have been sudden, and not effected by gradual incroachments upon the earth, to destroy its inhabitants. The examination of masses of flesh belonging to some of the race destroyed by the last change, and preserved by the frozen water in which they were imbedded, seems to prove that the death of the animals, and their envelopment in water, the coagulation of the water, and the introduction of a frozen climate, were simultaneous; for the putrefactive process had not commenced till thousands of years after the destruction of life, when, the ice being thawed, the exposure to heat and air began the decomposition. But the sudden violence by which these last changes were effected is equally conspicuous in the transport of huge blocks from one part of the country to another in which they were manifestly strangers.

But we ascend to greater heights on the surface of the globe, and we find the scene changed. We are now upon the vast and lofty chains of solid rock which traverse the central parts of the different continents, separate the rivers that water and drain them, veil their summits in the clouds, and are capped with never-melting snows. These are the primitive mountains; formed before any of the other new-made strata whereof we have already spoken, because they penetrate them vertically; and even these primeval rocks show by their crystallisation, and occasionally by their stratified forms, that they, too, were once in a liquid state, and deposited by waters which anciently held them in solution and covered the places they now fill. In these, as we ascend to the most ancient, no animal remains at all are found. The shells and other marine productions so abundant below, and in the more recent layers of the globe, here cease altogether to exist. The primeval rocks, therefore, were first held in a liquid state, and afterwards deposited, by an ocean which contained in its bosom no living thing; an ocean which before covered, or washed, a continent, or islands, on which life never had existed.

There is also little doubt, according to Cuvier, though we give not this as an incontestable proposition, that the prodigious changes which we have been contemplating must have been operated by a force wholly different from any that we now perceive in action upon any portion of the globe. The power employed to work some of the displacements of which we see the traces is shown remarkably in the insulated masses, found removed from great distances, and lying still at vast heights. On the

Jura, at near 4000 feet above the level of the sea, are found blocks of granite evidently carried from the Alps, one of which, containing 50,000 cubic feet of stone, has been removed and placed in its present position after the formation of the strata on or among which it lies,—strata, the materials of which do not fill its interstices, but have been rent and broken by its fall. None of the operations now observed on the earth's surface satisfactorily explain either this or the other revolutions in question. The effects of weather, either in the fall of rain, or in alternate freezing or thawing of water, though sufficiently powerful and very beneficial upon a small scale in decomposing stones and pulverising earths, are confined within comparatively narrow limits. The action of rivers in wearing down their banks, and changing the position of their beds, is restricted to those banks and beds, and is of slow and almost imperceptible operation, unless in some cases of rare occurrence, where a mountainous eminence being gradually undermined may fall and dam up a river and cause a lake to be formed, or where a lake may be let out of its reservoir by the wearing away of some ridge forming its dam or head, and so inundate the country below—events barely possible be it observed, and of which the period of authentic history records scarcely any instance. Then the incroachments of the sea are even more gradual than those of rivers; nor can any proof be found, in all the time over which authentic human annals reach, of a material change in position of the ocean with respect to its shores; the utmost it has ever done being to wear away an isthmus here and there,* or cover a mile or two of low and flat coast.* The wonderful force of a column of compressed water, in a vertical fissure connected with a subterraneous sheet of it, however shallow, but filling a broad space—the resistless power of such a column to move about any superincumbent weight—has, perhaps, been too little taken into account as an agent in effecting changes on the earth's surface. But these operations must be all merely local. Volcanic action is still more topical in its sphere; and though violent enough within these narrow limits, produces consequences wholly confined to them, and unlike those which are under consideration. Lastly, whatever effect could be produced by the motion of the earth is of incomparably a more slow and gradual kind than any now enumerated. The motion of the poles round the plane of the ecliptic, and the nutation of the axis, are movements of this kind, and never exceeded certain narrow limits. The rotation of the earth has a regular and defined tendency to accumulate matter towards the equator, and flatten our globe at the two poles, but no other; and certainly neither a sudden nor a violent effect can be operated by this means.

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* There seems reason, from some ancient authorities, to

The result of the Researches upon the fossil bones of land animals has demonstrated those changes still more incontestably than the examination of the remains which have been left by the

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believe that the Isle of Wight was once a peninsula when the tide was out, to which tin, the staple of the ancient British exportation, was carried in waggons at low water to be shipped for Gaul.

* The estate of Earl Godwin in Kent, now covered by the sea, is one of the principal examples of this kind of change; and there must clearly be great exaggeration in the accounts *given of it.*

nhabitants of the ocean; both because, as they nust have lived on dry land, their being found in trata deposited by water proves that water has overed parts of the continent formerly dry, and lso because, their species being fewer in number nd better known, we can now certainly tell whe-her or not the fossil animal is the same with any till living on the globe. Now of the one hundred nd fifty quadrupeds examined by Cuvier, and hose remains are found deposited in different trata of our continent, more than ninety are at resent wholly unknown in any part of the world; early sixty of these are of genera wholly unknown, he rest being new species of existing genera; only leven or twelve are so like the present races as to eave no doubt of their identity, or rather of their steology being the same; while the remaining fty, though resembling in most respects the exist-ng tribes, as far as the skeletons are concerned, ay very possibly be found, on more close survey, nd on examining more specimens, to differ mate-ially even in their bones. Nor is it at all unlikely hat, of the whole one hundred and fifty, every one ould be found to be of a race now extinct, if we ould see their softer parts as well as their bones nd their teeth. But the relation which these ifferent species of ancient animals bear to the ifferent strata is still more remarkable and more nstructive in every point of view.

In the *first* place, it appears that oviparous uadrupeds, as crocodiles and lizards, are found in arlier strata than those containing viviparous ones, s elephants and others. The earth which they nhabited must, therefore, have existed and been atered by rivers before the chalk formation, because they are found under the chalk in what is termed the Jurassic formation.—But, *secondly*, among the strata subsequent to the chalk formation, the unknown genera of animals, palæotheria, anoplotheria, are only found in the series of beds immediately over the chalk. A very few species of known genera of viviparous quadrupeds are found with them, and also some fresh-water fishes. —*Thirdly*. Certain extinct species of known genera, as elephants, rhinoceros, are not found with those more ancient animals of extinct genera. They are chiefly found in alluvial earth, and in the most recent tertiary strata, and all that we find with these extinct species are either unknown, or of more than doubtful identity with any now existing. Again, those remains which appear identical with the known species are found in recent alluvial earths, and places which seem to belong to the present world.—*Fourthly*. We have seen that the most ancient secondary strata contain reptiles and no other quadrupeds. None of the rocks at all contain any human remains; nor were any remains of the monkey tribe, or any of the family of quadrumanes found in Cuvier's time, if indeed they are observable even now. In turf-bogs, in rents and cavities, under ruins as well as in cemeteries, human skeletons are from time to time found; but not a vestige of them or of any human bone in any of the regular strata, or of the fissure deposits, or of the caves and caverns which abound with all the other animal remains. Whatever human bones have been found, were undoubtedly placed there by human agency in recent times.

For Cuvier has examined with the utmost care all the instances which were pretended to afford proofs of human remains. He closely investigated several thousands of the bones in the Paris basin, and in the deposits of Provence, Nice, and others. All which had ever been supposed to be human he found to be either animal bones, or bones of men accidentally placed among the others, or in some other manner satisfactorily accounted for. The skeleton supposed by Scheutzer to be a man's, and which he made the subject of his book "*Homo Diluvii Testis*," a century ago, has been already adverted to. Cuvier undertook the complete examination of it. The first skeleton which formed the subject of Scheutzer's argument was found near Amiens. Thirty years afterwards another was discovered, but its possessor, Gesner himself, raised grave suspicions that it was some lower animal's remains. A more complete one than either was afterwards found. Cuvier has engraved this, together with Scheutzer's copied from his own book —and how any person could, upon the bare inspection, ever have conceived that either was a human skeleton is truly incomprehensible. But Cuvier has further engraved a land salamander, whose osteology he had, after his admirable manner, thoroughly examined, and its likeness to the fossil remains shows it to be of the same genus, though of a wholly new species, above six times larger. He enters at large into the details of the difference between these remains and the human skeleton. But a further demonstration of their nature was reserved for him when, in 1811, at Leyden, he had access to the actual fossil itself of Scheutzer, and was permitted to remove a portion of the incrusting stone. He did this with the salamander by him, and predicted the kind of bones that would be discovered by the operation. The success of the experiment was complete; and to show the difference between this skeleton and a human subject, Cuvier had the satisfaction of also discovering a double row of small and sharp teeth, studding the fringe or border of the large circular mouth. In 1818, he had an opportunity of repeating this examination upon the last found specimen, which is now in the British Museum, and with exactly the same result. It is therefore demonstrated, as clearly as any fact in the whole compass of physical science, that these bones belong to a race wholly different from the human species, and indeed from any species now existing on the face of the globe. Finally, places where human bones have for many centuries been deposited with the remains of animals, as the ground under ancient fields of battle, have been examined, and it is found that the one are quite as well preserved as the other, and have not suffered more decay. The importance of establishing the conclusion that no human remains are to be found in the strata of the earth will presently appear, and is the reason why we have dwelt upon the evidence in some detail.

If we next inquire at what period the last great change took place, although of course no records can remain to fix it, yet we have some data on which to determine the limits of the question. The progress of attrition in the larger rivers, as the Dnieper and the Nile, and also the formation of downs where they approach from the sea, has been observed, as on the coast of the Atlantic in the south of France; and the results indicate no very remote antiquity as the age of the present terraqueous distribution; certainly not more than 5000 or 6000 years. Of these, history only goes back about 3000. Homer lived but 2800 years ago. Genesis cannot have been written earlier than 3300 years back. Even the earliest Chinese monuments that are authentic reach but 2255 years. The astronomical remains of the East, when closely examined, especially the Zodiac, prove nothing of that extreme antiquity which was at one time ascribed to them. Nor do the mines, such as those of Elba, from which similar inferences were formerly deduced, show, since their more accurate examination, anything of the kind. Indeed none of the conclusions they lead to can be regarded as at all of a certain kind. The general result of the Inquiry, then, is, that at a period not more remote than 5000 or 6000 years ago, a mighty convulsion covered with the ocean all those parts of the globe then inhabited by man and the other animals his contemporaries, and left dry those other portions of the earth which we now inhabit. The few remains of the races then destroyed have served to people this new world; it is only since this period began that we have entered upon the progressive state of improvement in which our race has advanced; and to this period whatever historical monuments we possess of the globe or its inhabitants are confined. But it is equally clear that this inhabited earth, then left dry for the last time, had previously undergone several revolutions, and had been alternately dry land and covered with the ocean, more than once, or even twice, before this last revolution. We have access more particularly to examine the condition and population of the earth when it was last inhabited, that is, when the sea left it the last time but one. We are now living in the fourth era or succession of inhabitants upon this earth. The first was that of reptiles; the second that of palæotheria; the third of mammoths and megatheria; and it is only in this present or fourth æra in succession that we find our own species and the animals which have always been our companions.

We are entitled then to affirm that, with respect to animal life, three propositions are proved, all of great curiosity, and still more, when taken either separately or together, all leading to conclusions of the highest importance—

First—that there were no animals of any kind in the ocean which deposited the primary strata, nor any on the continent which that ocean had left dry upon its retreat;

Secondly—that the present race of animals did not exist in the earlier successive stages and revolutions through which the globe has passed;

Thirdly—that our own species did not exist in those earlier stages either.

Now the conclusion to which these propositions leads, and which indeed follows from any one of them taken singly, but still more remarkably from the whole, and most especially from the last, is that a creative power must have interposed to alter the order of things in those early times. That an interposition of this kind took place, the last and most important, about 6000 years ago, is highly probable from the physical and natural evidence alone which is before us, and to which alone in this work reference can be made. But the date is not material. If at an uncertain period before the present condition of the earth and of its inhabitants, there were neither men nor the present race of creatures, wild and domestic, which people the globe, then it follows that between that period, whensoever it was, and the earliest to which the history of the world reaches back, an interposition of power took place to create those animals, and man among the rest. The atheistical argument, that the present state of things may have lasted for ever, is therefore now at an end. It can no longer be affirmed that all the living-tribes have gone on from eternity continuing their species; and that while one generation of these passed away and another came up in endless and uninterrupted succession, the earth abided for ever. An interruption and a beginning of that succession has been proved. The earth has been shown not to have for ever abode in its present state; and its inhabitants are demonstrated, by the incontrovertible evidence of facts, to have at one time had no existence. Scepticism therefore can now only be allowed as to the time and manner of the creative interposition; and on these the facts shed no light whatever. But that an act of creation was performed at one precise time is demonstrated as clearly as any proposition in natural philosophy, and demonstrated by the same evidence, the induction of facts, upon which all the other branches of natural philosophy rest.

It is wholly in vain to argue that the sea or the earth, or the animals formerly existing and now extinct, or any other created beings, or any of the powers of nature, as we know it, or as it has ever been known, could have made the change. It is difficult enough to conceive how these known forces could ever have destroyed the earth's former inhabitants. But suppose the approach of some comet or other body at different times produced the vast tides by which the land was successively swept, this will not account for new species and new genera of living creatures having sprung up both to inhabit the land and to people the waters. An act of creation—that which would now be admitted as a direct interposition of a superior intelligence and power—must have taken place. This is the sublime conclusion to which these Researches lead, conducted according to the most rigorous rules of inductive philosophy, precluding all possibility of cavil; accessible to every one who will give himself the trouble of examining the steps of the reasoning upon which they repose, and removing doubt from the mind in proportion as their apprehension removes ignorance. It is an invaluable addition to the science of Natural Theology, and forms a chapter as new in kind as any of the new animal species are in Natural History.

Such are the benefits conferred upon the great and fundamental argument of Divine Intelligence and contrivance by the recent discoveries in Fossil Osteology. The evidence of design in the combination and mutual adaptation of the parts of extinct animals we pass over as only a multiplication of proofs sufficiently numerous before. But the other branch of Natural Theology, that which investigates the Divine Benevolence, also derives aid from this new quarter. We now refer to the argument maintained in the Dissertation upon the Origin of Evil, and also to the theories which were there very respectfully considered, and diffidently and reluctantly found to be unsatisfactory. The late interesting discoveries have thrown new light upon both these subjects of discussion, and the authors of some of the systems which we examined may appear to the improved state of our knowledge respecting the Chain of Being, as we certainly do make our appeal to it upon what appears to be a more solid ground of argumentation.

The doctrine respecting the Chain of Being is admitted to be incomplete as regards the matter of fact, inasmuch as we find many and large blanks in the series of animated creatures known upon our globe. Whatever other objections, therefore, were competent against this theory, an additional one was, that little appearance of a Chain of Being seems discernible in the universe. Now, the supporters of this doctrine have certainly a right to maintain that the blanks are filled up in a very remarkable manner by the recent discoveries. For the new species of animals discovered to have existed in former states of the globe, unquestionably fill up some of the most remarkable chasms in our series of living animals. Thus the chief blank was always observed in the pachydermatous animals, the fewest in number, the least approaching one another, and the whole tribe the most removed from others. Now most of the new and extinct kinds of quadrupeds belong to this class, and we have had occasion to observe how links are supplied between race and race hitherto appearing altogether distinct.

But although we may not be justified in reposing great confidence in the argument drawn from the plan of a Chain of Being as applied to the subject of positive evil, there is another point of view in which the subject may, with perfect safety, be considered. As far as regards mere defect, mere imperfection, it is most important to consider whether the plan of Divine Providence may not have been to create a succession of beings rising one above another in attributes; say merely of intelligent beings thus differing in their approaches to perfection. The importance of this consideration cannot fail to strike the observer when he reflects that there is no possibility of separating one of the greatest of all positive evils, death itself, from mere defect or imperfection, as was observed in the Dissertation already referred to; not to mention many other kinds of evils arising from mere imperfection,—as all that proceed from weakness, from ignorance, from defect of mental energy, as well as mental perspicacity. All these evils, and all their various consequences, originate in mere defect or imperfection. Therefore it is of no little moment in this important argument that we should be able to derive any new light to guide our steps upon that part of the ground which belongs to defect or imperfection.

Now the late discoveries certainly afford us some such lights. They show as plainly as the evidence of facts can show anything, that there was a time when this globe existed with animals to people it, but without any beings at all of the human kind. The sounder opinion certainly is, that there has been a succession of stages through which the earth has passed, with different races of animals belonging to each period; that in the earliest age of all no animal life existed; that this was succeeded by another in which reptiles were found to flourish, and that subsequent periods were marked by other successive races of animated beings. But as this is the subject of controversy, we shall only say that there have been two eras, one in which inferior animals only existed without man, and the other in which we now live, and in which our species are the principal inhabitants of he globe. This is admitted by all who have considered the evidence; and they who the most strenuously deny the other doctrines of Fossil Osteology avow their implicit belief in the great proposition, that the relics of an age are clearly discovered in which man had no existence.

Now this position is most important with a view to our present argument. It appears that there was a time when the Creator had not brought into existence any being above the rank of the lower animals. It follows that the divine wisdom had not then thought fit to create any animal endowed with the intelligence and capacity and other mental qualities of the human species. If an observer had been placed in that world, and been called upon to reason regarding it, what would have been his reflections on the imperfections of animated nature? Yet, after a lapse of some ages, those defects are all supplied, and a more accomplished animal is called into existence. The faculties of that animal, and his destinies, his endowments and his deficiencies, his enjoyments and his sufferings, are now the subjects of the observer's contemplation and of his reasoning. What ground has he now for affirming that a more perfect creature may not hereafter be brought into existence—a creature more highly endowed and suffering far less from the evils of imperfection under which our race now suffers so much? No one can tell but that as many of the former inhabitants of the globe are now extinct—tribes which existed before the human race was created—so this human race itself may hereafter be, like them, only known by its fossil remains; and other tribes found upon other continents, tribes as far excelling ours in power and in wisdom as we

excel the mastodon and the megatherium
ancient world.

It is to be further observed that no ur
being can, by the nature of the thing, ha
right to complain of not being brought int
ence earlier. The human race cannot co
of having come so late into the world ; 1
any of the tribes created before us compl
they were less perfect than a species, the
which did not then exist. Have *we*, then,
habitants of the present world, any better re
complain that the new, as yet unknown,
creatures of a future period of the univer
not as yet come into existence? It must
fessed that the extraordinary fact, now made
and indisputably* known to us, of a world
existed in which there were abundance of
creatures, and none of our own race, gives
ground for believing it possible that Divine
dence may hereafter supply our place on th
with another race of beings as far superior
selves as we are to them which have gone be
But how inconceivably does this consic
strengthen and extend the supposition broa
the Dissertation upon Evil! How striking
it prescribe to us a wise and wholesome dis
the conclusions towards which human imp
is so prone to rush in the darkness of huma
rance! How loudly does it call upon us to
the old homely maxim, "When you are
dark, and feel uncertain which way to move
still!" How forcibly does it teach us that n

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* The kind of controversy which may be raised, b
has been raised on this point, is discussed in the 1
sertation.

may, that all which now we see as in a glass darkly, and therefore in distorted form and of discoloured hue, may, when viewed in the broad and clear light of day, fall into full proportion and shine in harmonious tints!*

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* Dr. Paley, in his twenty-fifth chapter, assumes, that whenever a new country has been discovered, with new plants and animals, these are always found in company with plants and animals which are already known, and possessing he same general qualities. From hence he derives an argument for the unity of the First Cause. Mr. Dugald Stewart also infers from the supposed identity of animal instincts in all ages, that the laws of physical nature must have always been the same, otherwise these animals could not have coninued to exist.

Now, *first* as to Dr. Paley's assumption. It certainly appears too large, even as regards the existing species and the present state of the globe; for there seem to be some places where all the animals are peculiar. But be that as it may, the fact assumed is by no means necessary for the support of Dr. Paley's conclusion in favour of the Divine Unity. It is extremely probable that in some former stages of our globe there were no animals whatever of the same tribes with those which to us are familiarly known. Yet can there be any doubt that in their structure the same degree of skill is observable as far as their only remains enable us to judge, and can we hesitate to believe, that were there other parts before us, we should in those find as much artistike contrivance as in the existing races of animals? Indeed we may go further and assert, that there is every ground for supposing that the same kind, as well as an equal measure of skill, is to be traced in the lost as in the existing tribes, and that, consequently, the characteristic argument will equally apply here. The proof of this in the structure of the alimentary canal, which Cuvier was not acquainted with, will presently be considered.

Secondly. With respect to the observation upon instinct, unquestionably some doubt may be raised by the new discoveries; for we cannot feel any confidence in the assertion that the animals, whose skeletons alone remain, were endowed with instincts similar to those now in being, more especially the tribes of anomalous description, such as the pterodactylus and ichthyosaurus. We have never seen in life any animals combining the various forms which seem to have met in these extraordinary creatures. We cannot, therefore, feel entire confidence in the belief that their habits or instincts resembled those of any combination of animals so dissimilar,—still less can we comprehend a harmonious union of the instincts proper to birds with those peculiar to reptiles, which yet the pterodactyli seem formed to obey. Dark, however, as is this department of the subject, we have abundant ground, from the preponderating weight of analogy, for resting satisfied that all their instincts, whatever they may have been, were nicely adjusted to their bodily powers, and that both their bodies and their instincts were as nicely adapted to the laws of matter and of motion.

It would be improper not to mention at the close of this Analytical View, that the science of Palæontology was much indebted to some able and learned men who were contemporaries of Cuvier. The examination of the Paris Basin, as regards its mineral character, was almost wholly the work of Brongnart, and it is allowed to be a model in that kind. Cuvier's brother, also, ably assisted him in the botanical department. The labours of Lamarck in conchology are so universally known as to need no further mention; and among other names may be stated that of Miller of Bristol, as having made valuable contributions to these inquiries.

LABOURS OF CUVIER'S SUCCESSORS.

MANY learned men were attracted by the discoveries of Cuvier, and devoted themselves to the cultivation of the same science. During the last twelve or fifteen years of his life they had joined in similar pursuits, and many of his opinions were modified, and many of his researches were materially aided, by their diligent and successful inquiries. As far as regards the general connexion between Organic Remains and Geology, indeed another inquirer had appeared in the field as early as himself, the laborious, modest, and sagacious William Smith, a civil engineer, who, unassisted and almost unknown, had been prosecuting his researches into the mineral state of England, and performed certainly the most extraordinary work that any single and private individual ever accomplished—the delineation of the strata of the whole country, in a set of underground maps, which he published in 1815, and followed afterwards with a work upon the relation between these strata and their Organic Remains. Although the results of his investigations were published thus late, he had many years before communicated the greater part of them freely to his private friends. It must be confessed that few men of greater merit, or more unassuming,

have ever adorned any walk of science, a
have ever made a more important step in a
the progress of discovery.

The other able persons who have cultivat
branch of science are certainly endowe
greater learning, that is, book learning, th
Smith could boast of, beside attending cl
actual observation in the field. Some of the
may fairly claim a high place as men of pr
and original views. Where so many exc
prefer claims so undeniable to the gratitude
world, it is invidious as well as difficult to
selection, the rather as, happily, we still h
great benefit of their continued assistanc
Italy, Brocchi; in Switzerland, Studer,
Charpentier, and Agassiz, the able and zeal
ciple to whom Cuvier gave up the departn
fossil ichthyology, when composing his w
Comparative Anatomy; in Germany, Von
Kaup, Count Münster, Goldfuss, Rosen
Wagner, and the justly celebrated Humbo
Russia, Fischer; in Belgium, Burtin, O
Dumont; in France, Beaumont, Brongnart,
ville, Prevost, Boué, Brochant, Geoffroy;
England, Conybeare, Mantell, Lyell as inci
his Geological Treatise, Clift, Delabeche,
Hibbert, Broderip, Fitton, Bakewell, Gree
Owen, Murchison, Professor Sedgewick, a
Buckland. These, it is believed, are all,
Brocchi, fortunately still alive, and still a
engaged in the same interesting inquiries,
some of them rather confine their study to t
logical portion of the subject. If from the
ant assemblage the names of Sedgewick and
land were selected, but, as regarding Foss

ology, the latter especially, private friendship could hardly be charged with officiously assuming to be the organ of the general voice—but, indeed, to record such merit might well seem presumptuous, where the panegyric is far less likely to reach aftertimes than the subject of its praise.

The labours of Cuvier's successors, as far as regards his doctrines, belong to one or other of three classes: to the progress which they have made in examining the fossil remains of former worlds, or conditions of our globe;* to the arguments which they have advanced in opposition to or in support of his theory respecting the relation that subsists between those animal remains and the strata in which they are found; and to the arguments adduced for or against his opinions respecting the formation and age of those strata. It may be proper to mention the things done under each of these heads, although the last is of comparatively little importance to the purpose of the present work, and the second is of considerably less moment, as regards Cuvier's proper subject, than the first.

I. Among the extinct mammalia of the pachydermatous order, we mentioned one which Cuvier referred to the tapir genus, but pronounced to have been of a gigantic size. He only had seen the jaw teeth of the animal. But since his time other important parts have been found, chiefly at Epplesheim, in Hesse Darmstadt: and a genus *Dinotherium* (having four species) has been established, of which this species is termed *giganteum*, his length having been apparently not less than eighteen or

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* The notes to the Analysis of Cuvier contain statements of the numbers of new species discovered since his time.

arguments that he must have lived chiefly
water, and these tusks in all probabilit
used in supporting him, anchored as it were
side of the river or lake while his huge body
as well as employed in digging for the roo
which his teeth show that he fed.

Notwithstanding somewhat scanty ma
Cuvier had described and, as it were, resto
megatherium with extraordinary skill. Bu
ther importation of bones from South Ame
enabled observers in this country to thro
additional light upon the structure and habit
singular animal. These bones were found in
of the river Salados in Buenos Ayres, a suc
of very dry seasons having brought the wa
usually low. Mr. Clift, of the Surgeons' M
a most learned and skilful comparative ana
and pupil and assistant of John Hunter, ex
them fully, and found many very singular par
not before known respecting this animal.
other things it appears to have a bony partit
tween its nostrils (septum narium) like the rhi
tichorhinus. The structure of its teeth in

the extremities of the processes was no less than twenty-one inches. If then allowance be made for the muscle and integuments, it could not have been less than two feet in diameter at the root, and six feet in girth. There can be little doubt that it was used both as a weapon of defence and to support the animal in conjunction with part of his large feet, while the others were employed in digging or scraping away the earth in quest of his food. The fore feet were a yard long, and the bones of the fore legs were so constructed that the limb could have a lateral or rotatory horizontal movement for the purpose of shovelling away the soil. The bone of the heel is also of extraordinary length. The proportion of his bones to those of the elephant is very remarkable. The first caudal vertebra in the megatherium being twenty or twenty-one inches, in the elephant it is barely seven. The circumference of the thigh in the former is two feet two inches, in the latter one foot. The expanse of the os illii in the former no less than five feet one inch, in the latter three feet eight inches. The bony cover of the hide has also been now more fully examined. It was about an inch in thickness, and so hard as to resist all external violence. The cumbrous movements of this unwieldy creature exposing it to many kinds of danger, the hide served to defend it from some enemies, and the weight and strength of its limbs and tail enabled it to destroy others; escape from any by flight being quite impossible. Mr. Clift informs me that he has found in the region of the pelvis small lumps of adipocire. So that we have here an additional instance of the softer parts of an extinct animal still preserved in a state to which flesh is now often reduced by decomposition in water.

Mr. Darwin (grandson of the celebrated physician and poet) has found in South America many interesting remains. Among these are the bones of an edentate, between the megatherium and armadillo (largest kind); those of a huge rodent in size equal to the hippopotamus; and those of an ungulate quadruped the size of a camel, and forming the link between that class and the pachydermata.

In the lias stratum of Lyme Regis there was found in 1828, by Miss Anning (to whose skill in drawing, as well as her geological knowledge, Cuvier often acknowledges his obligations), a new species of pterodactyle with very long claws, and hence Dr. Buckland gave it the name of *Pter. Macronyx*. It appears to have been the size of a raven.

In 1824, Mr. Mantell discovered in the Tilgate sandstone, in Sussex, the remains of an herbivorous reptile allied to the iguana genus, but vastly larger; and he gave it the name of *Iguanodon*.* Other parts of the animal have since been found in different places, as in Purbeck, and in the Isle of Wight. Mr. Murchison found a thigh bone three feet seven inches long; and in 1829, a metacarpal bone, of six inches long by five wide, was found in the iron sand, and a vertebra as large as an elephant's. The opinion of Cuvier referred the large thigh bone clearly to Mr. Mantell's reptile, whose dimensions must therefore have been enormous, though it was not carnivorous.

In 1834, a large proportion of the skeleton was found in the Rag quarries near Maidstone. This confirmed all the previous conjectures as to the bones separately discovered. The length of this monstrous reptile is calculated to have been seventy feet from the snout to the tip of the tail, the tail to have been fifty-two feet long, and the body fourteen feet round.* Mr. Mantell also discovered in 1832, in Tilgate Forest, the remains of a lizard, which may have been twenty-five feet long, and was distinguished by a set of long, pointed, flat bones on its back, some rising from it as high as seventeen inches in length. He called it *Hylæosaurus*, from being found in the Weald.

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* This discovery had been made before the last edition of Cuvier's book, and is mentioned, though shortly, in the Analysis.

There were found in 1836, a great collection of fossil bones in the department of Gers, in France, in a tertiary fresh-water formation. Above thirty species, all mammalia, were traced, and of these the greater part were new extinct animals, but all were of extinct kinds; two species of the dinotherium; five of the mastodon; a new animal allied to the rhinoceros, and another to the anthracotherium; a new edentate; and a new genus between the dog and racoon; but the most singular and new of the whole is the under jaw of an ape, which appears to have been thirty inches in height. But we must be very cautious in giving our assent to this, until we are better informed of the position where the jaw was found. It is certainly possible; but after the history of the Guadaloupe skeleton, clearly human, as clearly found among fossil remains, but now universally admitted to have been a recent deposit, we may pause before concluding that a deposit contrary to all other observations of fossil bones should have occurred in any tertiary formation.*

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* Geol. Trans. N. S. vol. iii. pt. 2.

In the time of Cuvier, at least before the completion of his great work, our knowledge was so scanty of the fossil osteology of the East, that we doubt if any allusion to it is ever made by him. Three most important contributions to this branch of science have since extended our knowledge in that direction, and a rich addition may soon be expected from Mr. Clift's labours upon a large recent arrival.

The first was by my excellent friend Mr. Craufurd, who, travelling in the Burman empire, was fortunate enough to discover a great number of fossil remains near the river Irawadi. These he generously gave to the Geological Society, and Mr. Clift proceeded to examine them with his wonted assiduity and skill. Among them were traced two new species of mastodon, in addition to the M. gigas, and M. angustidens, of Cuvier. One is termed by Mr. Clift *Latidens*, from the breadth of his jaw teeth; and the bones of his face exceed in size those of the largest Indian elephant. The other he calls *M. Elephantoides*, because his teeth approach much nearer the elephant's than those of Cuvier's species, or of the Latidens. This animal appears to have been smaller than the elephant. A hippopotamus smaller than the living animal, a rhinoceros, a tapir, and others, have also been

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* I have lately seen an appearance of a stratum of calcareous matter, which a cursory observer would certainly have supposed to be a natural deposit in the ground; but its history was known from some rubbish through which lime had filtered, when part of Buckingham House was built, and there were bricks, tiles, &c., underneath it.

ced among these remains, as have a new lizard
ar the garial, and a crocodile near the common
imal.*

The second of these discoveries was made on the
rth-east border of Bengal, at Carivari, near the
ahmaputra river. The remains were examined
Mr. Pentland. He traced a new species of
thracotherium, which he calls *Silicestre*, a new
rnivorous animal of the weazel tribe, and a pachy-
rmatous animal much smaller than any hitherto
own, either living or fossil.†

The third and most remarkable of these col-
tions is one discovered in the Markanda valley,
d the Sivalik branch of the Himalaya moun-
ns, in the year 1835. The curiosity of naturalists
India was immediately roused, and their industry
ected towards the subject with that ardour which
relaxation of a sultry climate never abates, and
t combined perseverance and ability which has
er marked the great men of our eastern settle-
nts. Dr. Falconer and Captain Cautley have
iefly signalized themselves in this worthy pursuit;
luable aid has likewise been rendered by Lieut.
rand; and the result of their labours occupies
e-half of the Asiatic Researches for 1836. They
nd first of all a new animal, of the ruminating
ss, whose skull is the size of a large elephant's,
d which has two horns rising in a peculiar
nner from between the orbits, with an orifice
great breadth and an extraordinary rising of
bones of the nose. They gave it the name of
vatherium, from the place of its discovery, dedi-
ed to the deity Siva. The breadth of the skull

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* Geol. Trans. N. S. vol. ii. pt. 3.

† Ib.

is twenty-two inches. Dr. Buckland has r
that it must have had a trunk, something i
diate between the elephant's and tapir's.
next found a hippopotamus of a new spec
tinguished by having six incisive teeth, and
materially different from the other species,
living or extinct. A new species of tiger
discovered, which they called *Felis Crist*
tinguished chiefly by the great height of tl
pital bone. In the same place with thes
were found remains of the mastodon, an
known species of extinct animals; but the
teresting discovery was that of a camel, o
the skull and jaw were found. It is to be
that no decisive proof of any of the Camelida
camel, dromedary, or llama, had ever been
found among fossil bones, although Cuv
proved certain teeth brought from Siberi
undoubtedly of this family, if they were real
which he doubted. This discovery in In
therefore extremely interesting, as supp
wanting genus. But for this very reason it
the more necessary to authenticate the po
this supposed camel's remains the more
especially as there were abundance of
camels in the country, which there could
in Siberia. The Indian account is somewhat
in this respect, leaving us in doubt whether tl

Besides all these additions to our knowledge of ecies and genera, two remarkable observations or ets of observations have been first made by osteo-ogists since the time of Cuvier. The one of these s the tracing of footsteps, the print of which has een left by animals upon the sand, or other mate-ial of the strata, while in a soft state. The other s Dr. Buckland's study of the intestines from their fossil contents, which he has called *coprolites*.* The first of these curious inquiries is conducted by observing the impressions which the softer and more destructible parts of animals, whose very race has been extinct for ages, made upon the earthy strata of a former world; it is the object of the other inquiry to ascertain from the petrified fæces bearing the impress of the alimentary canal, the internal structure of extinct animals; and both subjects are certainly calculated powerfully to arrest our attention.

The footsteps, it appears, were first observed by my reverend and learned friend, Dr. Duncan (to whom the country is also so deeply indebted as the author of savings' banks), in Dumfriesshire. On examining a sandstone quarry, where the strata lay one over the other, or rather against the other, for they had a dip of forty-five degrees, he found these prints not on one but on many successive layers of the stone; so that they must have been made at distant periods from each other, but when the strata were forming at the bottom of the sea. No bones whatever have been found in those quarries. Similar impressions, though of smaller animals, have been observed in the Forest marble beds near Bath. The marks found in Dumfriesshire, of which there were as many as twenty-four on a single slab, formed as it were a regular track with six distinct repetitions of each foot, the fore and hind feet having left different impressions, and the marks of the claws being discernible. They appear to have been made by some animal of the tortoise kind.* But similar marks have since been found in other parts of the world. At Hessberg, in Saxony, they have been discovered in quarries of grey and red sandstone alternating; the marks are much larger than those in Scotland, and more distinct. In one the hind foot measures twelve inches in length, and the fore foot is always much smaller than the hind. From this circumstance, and from the distance between the two being only fourteen inches, it is conjectured that the animal was a marsupial, like the kangaroo. But one of the most remarkable circumstances observed is, that the upper stratum has convex marks answering to the concavity of the lower slab on which it rests, clearly showing that the former was deposited soft after the latter had been first printed by the foot in a soft state and then somewhat hardened. Dr. Kaup has termed the large unknown animal *Chirotherium*,† from the supposed resemblance of the four toes and turned-out thumb to a hand. In the summer of 1838 similar footsteps of the chirotherium, and of four or five small lizards and tortoises, with petrified vegetables of a reedy kind, have been observed in the new red stone at Storeton Hill quarry in Cheshire, near Liverpool. A discovery has within the last two years been made in the state of Connecticut, near Northampton, where the footsteps of various birds, differing exceedingly in ize, are found in inclined strata of sandstone, and evidently made before it assumed its present posiion. The marks are always in pairs, and the tracks cross each other like those of ducks on the margin of a muddy pond. One is the length of fifteen or sixteen inches, and a feathery spur or appendage appears to have been attached to the heel, eight or nine inches long, for the purpose of enlarging the foot's surface, and, like a snow-shoe, prevent the animal's weight from sinking it too deep. The distance between the steps is proportioned to their length, but in every case the pace appears to have been longer than that of the existing species of birds to which they approach nearest, the ostrich. Consequently, the animal must have been taller in proportion to his size. How much larger he was than the ostrich may be gathered from this, that the large African ostrich has only a foot of ten inches long, less than two-thirds of this bird, and yet stands nine feet high. These proportions would give a height of fourteen feet to the extinct animal. Some of the footsteps in the Storeton Hill quarry are eighteen inches in length. In the Forest marble of Bath the foot-marks of small marine animals are descried.

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* Κοπρος, fæces: λιθος, stone.

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* Edin. R. S. Trans. 1828.

† *Χειρ*, hand.

In examining the inside of the ichthyosaurus, the half-digested bones of the animals on which these ravenous creatures preyed are found in large masses. But there are also scattered in great abundance among their fossil remains the fæces which they voided; and these being in a petrified state have preserved the very form of the intestines in minute detail. The fæcal matter is generally dis-

the mass; these are the remains, undige
contemporary fishes and reptiles, including
ones of the beast's own tribe, on which he
to have fed, as well as on other species. T
which these coprolites throw upon the stru
the animal's intestinal canal is sufficiently
able. The intestines are proved to ha
formed like an Archimedes screw, so that
ment in passing through was exposed wi
smallest space to the largest surface of a
vessels, and thus drained of all its juices, a
in the digestive process of living animal
similar structure of the intestinal canal
sharks and dogfish now existing has been
by naturalists; and Dr. Paley expressly
it as making compensation by its spiral pa
its being straight, and consequently short, c
with the intestinal passage in other anima
also can distinctly trace in these coprolites
and form of the folds of the mucous membr
lined the intestines, and of the vessels wl
along its surface. As there is no part of
mal frame more easily destructible than

some places they take so fine a polish that lapidaries have used them for cutting into ornamental wares. One of the most singular coprolites was found by Lord Greenock (an assiduous and successful cultivator of natural science) between the laminæ of a block of coal near Edinburgh, and surrounded with the scales of a fish recognised by Professor Agassiz as of contemporary origin. To these observations a very curious addition has been made by the Professor, who found that the worm-like bodies described by Count Münster, in the lithographic slate of Solenhofen, are in fact the petrified intestines of fishes, and he has also found the same tortuous bodies occupying their ordinary position between the ribs in some fossil remains. He has named them *Coleolites*;* and certainly the representation given of them in the drawing resembles an actual intestine as accurately as if it were the portrait of it.

When Cuvier abandoned to Professor Agassiz the whole department of Fossil Ichthyology, he showed as happy and just a discernment of living character as he ever displayed in the arrangement and appropriation of animal remains. That admirable person has amply earned the honour thus bestowed on him by devoting his life to this extensive, obscure, and difficult study. The results of his laborious researches have been from time to time published in a great work upon fossil fishes; but as the arrangement followed as yet in the publication necessarily leaves the several parts incomplete, a distinct and satisfactory view of the whole cannot be formed until the work is finished. Some

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* *Κωλον*, the great intestine.

of the different formations, while those of li
mals are confined each within certain lim
the fishes being also inhabitants of those
in which all the aqueous deposits once we
tained, we are enabled by Fossil Ichth
through various periods of the earth's fo
to pursue the comparison of a vertebrated
condition in each stage.

The Professor's classification is found
the form of the scales, which are adapted
structure of each tribe, and afford a perfect
tific principle of arrangement. He thus
the whole into four orders:—the *Placo*
whose scales are irregular enamel plates m
quently broad, but varying in dimensions
a point or prickle; the *Ganoïdeans*,† with
scales of bone or horn thickly enamel
shining; the *Ctenoïdeans*,‡ with comb-lil
having a jagged edge and no enamel;§ the
deans,‖ whose scales are smooth at the e
composed of horn and bone, but unenamel

There were in all 8000 species of fish enu been called into existence at a period long after the primitive, the transition, and all but the latest secondary formations. On the other hand, and in the earlier times of the secondary and transition strata, there existed species of the other two orders, which have comparatively few representatives surviving to our days. The Professor has thoroughly examined 800 fossil species of these two orders, and finds not a single exception to the rule thus laid down for the relation between different species of animals and successive formations of strata.* His deductions received further corroboration by the examination of 250 species, all of new and extinct fishes, submitted to him in England, and which were, for the most part, found in this country. The analogy in this respect between the results of Fossil Ichthyology and those of Cuvier's Researches is striking throughout. In the lower deposits of the lias there are found the remains of the great sauroïd fishes analogous to the fossil lizards of the same strata. More than two-thirds of the fishes found in the chalk strata are of genera now extinct. These extinct genera, however, of the newest secondary strata approach more nearly to the fishes of the tertiary strata than the fishes found in the oolite or Jurassic formation; insomuch that the Professor is disposed to range the chalk and green-sand nearer to the tertiary than secondary formations on this account. Not a single genus even of those whose species are found in the Jurassic deposits is now known among existing fishes; nor is there a single species, and but few genera common to the chalk, and the older tertiary strata.

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* Rapport sur les Poissons Fossiles, 1835, p. 38.

A third of those found in the strata of the later tertiary formation, as the London clay and the coarse limestone of the Paris Basin, are of extinct genera. The Norfolk crag and upper sub-appennine formation have, for the most part, genera found in the tropical seas; the tertiary formation generally approaches nearest to our living species, but the Professor affirms that, except one small fish, found in modern concretions on the coast of Greenland, not a single species exactly the same with those of our seas is to be found in a petrified state. This continued analogy is very important in a geological view.

In a zoological view it would be endless to attempt any analysis of the Professor's researches. Among the extinct species no less than 150 belonged to the family of sharks, whose services, in keeping down the increase, naturally so rapid, of fishes, have been required in all ages of the ocean. Different kinds of shark, however, appear to have belonged to different periods. Of the three sub-families into which the Professor divides the great class of sharks, the first is found in the earliest period of organic remains, the transition strata, and continues till the beginning of the tertiary, but there is now only one species of it existing, and that is found in New Holland. The second sub-family begins probably with the coal formations, and ceases when the chalk commences. The third begins with the chalk, and continues down through the tertiary formation to the present time. The form as well as the size of the extinct species differ in most things materially from the living, and in no respect do they vary more than in their covering or scales.

As the coprolites enable us to ascertain the interior structure of the extinct reptiles, so do they throw light upon that of fishes also, those especially of the sauroïd or lizard-like kind. We have even instances of their intestines being partially preserved by some fortunate accident. An example near Solenhofen has been mentioned already. A specimen was found in Sussex, where the stomach, with its different membranes, was retained. In a number of fishes found in the Isle of Sheppy the bony capsule of the eye was found entire; and in some other instances the plates forming the gills or branchiæ are perceivable.

It thus appears that great and important additions have been made to this interesting science since Cuvier, who may properly be termed its founder, ceased from his labours. But it would not be proper to pass from a consideration of the services rendered by his successors, without making mention of one illustrious inquirer, a man of truly original genius, who preceded him by a few years. John Hunter, whose unrivalled sagacity seemed destined to cast a strong light upon whatever walk of science he trod, had turned his attention, as early as 1793, to fossil bones, in consequence of a collection sent to this country by the Margrave of Anspach. He described and commented upon them in detail with his wonted acuteness; he adopted the same safe and natural course which Cuvier afterwards pursued with such signal success, of examining the known bones of existing species as well as those submitted to his consideration; and it appears, from some of his concluding remarks, that he perceived distinctly enough the specific difference of the fossil animals, at least of some among them. Thus, having compared the

fossil skull of a supposed bear with that of
bear which he had procured from the owne
animal while alive, he gives an accurate
of both, and marks their diversities, indicat
opinion that the fossil animal differed
known carnivorous animals.* Who does
ceive that he was on the right track, and
have reaped a plentiful harvest of discove
he devoted himself to the general investiga
the subject?†

II. The speculations of succeeding zoolo
comparative physiologists have not only
impression upon the anatomical results of
inquiries, but they never appear to have been
towards that object. Considering the nu
instances in which he had to draw his con
or to form his conjectures from a very in
collection of facts, it is wonderful how co
the fuller materials of his followers have co
his inferences. But geological inquirers
casionally impugned his doctrines respecti
relation of the classes of animals to the su
formations of the strata that incrust our gl
has been denied by some that any such rel
all can be truly said to exist. There seem
ever, no possibility of maintaining this
whether we agree wholly with Cuvier or no
detail of his statements. For the fact is un
that some strata, let them have been arra

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* Phil. Trans. 1794, p. 411.

† In the Hunterian Museum there is a large
of fossil organic remains, selected with consumm
and showing the attention bestowed by this great
the most delicate parts of organization which th
plify.

whatever succession, formed and placed by whatever causes, contain the remains of certain classes of animals which are not to be found in other strata. It is another fact equally indisputable, that no animals now exist of the same kind with the greater part of those found in any of the strata. This appears to connect the different races of animals with the different strata. But it is said that this is not a chronological connexion, and affords no evidence of strata having been formed rather in one age than another. If it were so, there still would remain a foundation for the position which merely affirms a relation between organic remains and strata. But is it true? The principal reason assigned is, that although no animals of a certain kind are found in certain strata, supposing those strata to have been formed at a given period, the animals of the kind in question may have perished so as not to have been washed into the sea or other water in which the earthy matter was mixed, and from which it was deposited. Now, not to mention that this bare possibility becomes improbable in the degree in which the facts are multiplied and the observations of animals and strata extended, the researches respecting fossil fishes seem to negative the objection entirely. For if the different strata were made by the sea, and contain totally different remains of marine animals, it is clear that each must have been formed respectively in a sea inhabited by different animal tribes. The strict parallelism, too, which is observed between the connexion of different races of animals and that of fishes with different strata, lends the strongest confirmation to Cuvier's doctrines.

Ingenious and laborious attempts have been made to show, that though many races of animals are now wholly extinct, the evidence fails to prove the non-existence of any race (except our own) at a preceding period; in other words, to disprove the proposition that many of the present races came for the first time into existence at a period subsequent to the time when we know that others existed, always excepting the human race, which it is admitted we have sufficient reason to believe did not exist in the earlier stages of the globe's formation. It cannot, however, be denied, *first*, that the extinction of many races of animals, which is admitted, affords a ground of itself for thinking it probable that new ones should be found to supply their places; *secondly*, that there seems nearly as little reason to regard the utter extinction of some classes as more improbable than the formation of others; *thirdly*, that the admitted creation of man destroys the whole support which the objection might derive from a supposed uniformity of natural causes, always acting, and removes the difficulty said to exist, of assuming different sets of principles to be in action at different periods of the world; *fourthly*, that the great number of facts which have been observed, all pointing uniformly in one direction, cannot be got over by suggesting mere possibilities for explanations. The improbability is extreme of one set of animals having existed at the same age with another set, when we find certain strata having the traces of the former without any of the latter, and *vice versâ*. This improbability increases in proportion to the number of the species. If these exceed hundreds, and even amount to many thousands, the improbability becomes so great as to reach what, in common language, we term a moral impossibility. Now, there are 6000 kinds of fishes, of which not one specimen is to be found in any of the formations preceding the chalk. But suppose we lay out of view all question of one formation being older than another, there are certain strata in which none of those species are found. There is no disposition to deny that these strata were formed in the water; therefore, at whatever time they were suspended in the water, that water at that time contained none of those 6000 kinds which now people it. Then from whence did they all come if they existed at that period, and yet were not in the water when the strata were formed? But it is equally admitted that the water in those days contained many other kinds of fish now extinct, and found only in certain strata, and it contained some few which we find in other strata, and some which are still to be found in the sea. Can anything be more gratuitous than to suppose that all the fishes of a certain class were destroyed at the formation of those strata, while all those of another class were afterwards brought from a different part of the sea to succeed the last ones, and a certain small number survived to mix with other strata, or even to last till now?

The only sound objection that can be taken to the theory, is that to which the absolute assertion of the fact is liable. We can easily ascertain that certain species are no longer to be found living on the globe. But we may not be so well able to affirm with certainty that certain fossil genera of one formation may not hereafter be found in another, or, which is the same fact in another form, that certain living species may not be traced among fossil remains. Thus the small family of the camel was wanting in all our fossil collections till the late discoveries in the Himalaya mountains have made it probable that a species of this class may be found to have existed there with the mastodon and other extinct mammalia. This is possible, perhaps likely. So an ape's jaw is supposed for the first time to have been found in a fossil bed in France with other races, and no quadrumane had ever been before traced in any part of the fossil world. The proof of this discovery is, however, as yet involved in some doubt, and even were it more precise, we should only have two instances in which the negative evidence had failed, leaving a multitude of others, hundreds of land and thousands of sea animals, of which no representatives are to be traced among the fossil remains of any country. It must always be recollected that the whole argument rests upon probability, more or less high. Even as regards the admitted non-existence of the human species, the mere evidence of osteological researches is not demonstrative; for although it is quite certain that among the thousands of animal remains which have been discovered and carefully examined, not a fragment of a human bone is to be found, it is barely possible that in some deposits as yet unexplored the skeleton of a man may be discovered. We have at present only to make our inference square with the facts; to affirm that, as far as our knowledge extends, there is no such relic of our race in the earlier strata of the globe; and to conclude that, considering the extent of past inquiries, the regularity of the connexion between other races of different kinds and various strata, and the portions of the earth over which our researches have been carried, the very strong presumption is against any such contradictory discovery being hereafter made.

III. Whatever opinion men may form upon the question raised by some antagonists of Cuvier's geological doctrines, all must allow that considerable light has been thrown upon the subject of discussion by their labours. Indeed a considerable addition to our knowledge has been made by some of these able and learned men, even admitting that they have failed to impugn the theory, and taking the facts which they have ascertained as forming an addition, by no means inconsistent with it. Thus the valuable work of Mr. Lyell has, in two essential respects, greatly advanced geological knowledge. He has examined, with a much more minute attention than had ever before been given to the subject, the action of the physical agents actually at work before our eyes, and has shown how extensively these may operate upon the structure of the earth's surface. It may be admitted, perhaps, that Cuvier had somewhat underrated their power, although the reader may still retain his opinion, that the force ascribed from the facts to those ordinary physical powers is inadequate to produce the effects which the phenomena present; that all the violent and sudden actions known on the globe are topical, being confined within comparatively narrow limits, and that the supposition of sudden and even instantaneous change on a vast scale in former periods has been too lightly taken up. Indeed, unless we suppose such changes as might happen from the disruption of a continent united by a small neck of land, like that which may be found once to have joined Gibraltar and Ceuta, it seems hard to imagine how a tract of country, extending from Holland to beyond the Caspian, and from Scandinavia to the Carpathian mountains, could be drained of the sea, which certainly once covered it, or, having still more anciently been dry, could have been laid under water.[*]

But a much more important service has been rendered by Mr. Lyell's comparison between the different formations of the tertiary class; and although it is with unavoidable distrust of himself that any one little versed in geological science should venture to speak, it should seem that the division which he has thus succeeded in tracing of the tertiary period, may stand well with the previous system of Cuvier, and be received as a fact independent of the controverted matter with which it has been connected. With the important aid of several eminent conchologists, but especially of Mr. Deshayes, he examined the numbers of testaceous animals traced in different formations; and finding that in some strata the proportion of shells of living species was very different from others, he distributed the strata of this tertiary period into three classes accordingly; the earliest being those which contained the fewest of our living species. The latest of the three periods into which he thus subdivides the tertiary era he calls *pliocene*,[†] or more recent; the next before *miocene*,[‡] or less recent; the earliest *eocene*,[‖] or dawning. Seventeen species of shells are common to the three divisions, of which thirteen still exist and four are extinct. In the pliocene the proportion of existing shells always exceeds one-third, and usually approaches one-half of the whole found. In the miocene, the existing shells fall considerably short of one-half, that is, the extinct species preponderate; indeed, of 1021 examined, less than a fifth were existing. There are 196 common to this and the last period, of which 82 are extinct. In the eocene period, the proportion of existing shells is much smaller, not exceeding three and a half per cent.; and there are only 42 common to this and the miocene. In the Paris Basin 1122 species have been found, of which only 38 are now known as living.

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[*] In Mr. Whewell's learned work on the History of the Inductive Sciences, there are some acute and important remarks on the two theories, that of Uniform Action, and that of Catastrophes. B. xviii. c. 8.

[†] Πλειων, more, and *Καινος*, recent.

[‡] *Μειων*, less.

[‖] Ηως, dawn.

The theory of Cuvier and Brongnart respecting the successive formations in the Paris Basin, appears to require some modification in consequence of more recent examination. They considered that upon the chalk there was laid, first a fresh-water formation of clay, lignite, and sandstone; then a marine formation of coarse limestone; and then upon that a second fresh-water formation of silicious limestone, gypsum, and marl. The researches of Mr. Constant Prevost seem to show that instead of these three successive formations, there were laid on the chalk a clay formation of fresh-water origin, and then upon that, contemporaneously, three others, in different parts of the same Basin, namely, a fresh-water formation of silicious limestone, another of gypsum, and a marine formation of coarse limestone. In the rest of the series the two theories coincide.

It must, however, be observed that the more important doctrines of Fossil Osteology, even as regards their connexion with the history and structure of the globe, do not necessarily depend upon the opinions which may be entertained of the more controverted points of geological theory, while the science of comparative anatomy exists alone, self-contained and independent of geology. But all must agree in admitting the important service which Osteology has rendered to geological inquiries, and in rejoicing at the influence which it has had upon those who pursue such speculations, in promoting a more careful study of facts, and recommending a wise postponement of theoretical reasoning, until the season arrives when a sufficient foundation for induction shall have been laid by the patient observer.

NOTES ON THE FOSSIL OSTEOLOGY.

NOTE I.

s some learned men are satisfied with the proofs of an e's jaw-bone having been found at Sansan, in the uth-west of France, and an astragalus of the same nus in the Sivalik hills, it is very possible that this nus may be added to those found in the strata of the iocene period; for it is only in the more recent formaons that these remains are supposed to exist. That ey should be found in any of the Pliocene formations in a high degree improbable; and even then we have ly got to the middle of the Tertiary period. No one ntends that in the earlier formations any such remains e to be traced.

But in case any objection should be raised to the arument in the text, upon the supposition that, because adrumanous animals were supposed by Cuvier not to traceable in any but the present portions of the globe's ust, therefore human remains may likewise hereafter found in earlier formations, we may remark that, even they were, contrary to every probability, there found, one pretends to expect such remains in those strata here no mammalia of any kind have been discovered; d the argument in the text is wholly independent of e particular period at which the non-existence of our ce is admitted. These considerations are fit to be rne in mind, since learned men, like Mr. Schmerling, e inclined to think that some human bones found in e same caves with the remains of hyænas and other

science of Palæontology now is, may make the
of its doctrines in any one year little applicable to
The notes to the Analysis of Cuvier, and the su
account of the labours of his successors, may
show what inhabitants of the former surface of
are at present within our knowledge. But wit
to the two important classes of ichthyosaurus an
saurus, the following abstract will prove conv
the student who would compare the present stat
information upon these two fossil genera at pre
what it was when Cuvier wrote. Nothing ca
exhibit the rate, as it were, at which this sci
been advancing. I am indebted to my learned,
excellent friend, Mr. Greenough, for this
which will be found to be marked with the accu
clearness, and the conciseness which distinguis
productions :—

ICHTHYOSAURUS.

1. Communis .... Cuvier, vol. ii. Lias—England
temberg.
2. Coniformis.... (See Journal of Acad. of Phila

2.	Carinatus	Lias—England and Boulogne.
3.	Dolichodeirus	Muschelkalk — Germany ; and lias—England.
4.	Pentagonus	Jura beds—France.
5.	Profundus	Variegated sandstone—Jura. Not known to Cuvier.
6.	Recentior	Kimmeridge clay.
7.	Trigonus	Calvados—north of France.
8.	Trigonus	Cuvier, vol. ii. p. 486. Lias, probably.

GENERAL NOTE RESPECTING EVIDENCES OF DESIGN.

All the inquiries in which we have been engaged lead to one conclusion of great importance. Notwithstanding the progress which has been made in various sciences, the things which have been discovered and ascertained bear an infinitely small proportion to those of which we are still either wholly ignorant, or imperfectly and dubiously informed. In a vast variety of instances, design and intelligence have been traced—instances so well deserving to be called innumerable, that we are entitled to believe in contrivance as the universally prevailing rule, and we never hesitate so to conclude. But the mode and manner of the working is still, in a prodigious number of cases, concealed from us; and we are entitled to infer that numberless things which now seem irregular, that is arranged according to no fixed rule, are nevertheless really disposed in an order which we have not discovered, which would, if we knew all, be as complete as that observed and traced in the cases known to us. Thus the regular working of bees, which we have been examining, is reducible to certain known rules; the figures formed by them are, in all their relations, familiar

ceivable form calculated to oppose a solid re
the pressure of water.* It appears probabl
works of spiders in concentric circles, and al
radii, are also regularly arranged in known fi
upon similar principles. Many of the parts
wear the semblance of regular and symmetri
lines, insomuch that a mathematician once pr
paper to the Royal Society (on some propositi
higher geometry), which he entitled, from th
the lines investigated, "*Fasciculus Florum*
corum." The orbits in which the heavenly bod
come manifestly within the same remark s
certainly; for the forms of those paths, the r
all their points to given straight lines, is in
degree ascertained. But it seems very reas
conclude, that the small number of such regul
which the state of science in its various bran
as yet enabled us to trace, is as nothing
with those figures still so unknown to us, that
mon speech we talk of them as irregular, whi
only a word, like chance, implying our own ign

For the mathematical sciences, extraordinar of man, are most probably still in their infancy. Of the infinite variety of curve lines, we know but a very few with any particularity, to say nothing of our equal ignorance (connected with the former) of most of the laws of complex motion. In the parts of animal and vegetable bodies, especially of the larger kind, there are few symmetrical forms observed; greater convenience, in the former instance at least, is evidently attained by other shapes. Yet there seems no reason to doubt that all the forms which we see may be in reality perfectly regular, that is, that each outline is a curve, or portion of a curve, related to some axis, so that each of its parts shall bear the same relation to lines similarly drawn from it to this axis, which all its other points do. If we know little of algebraical curves, we know still less of those whose structure is not expressible by the relations of straight lines and numbers, the class called mechanical or transcendental, the forms of some of which are very extraordinary, but all whose points are related together by the same law. There is every reason to expect that the further progress of science will unfold to us much more of the principles upon which the forms of matter, both organic and inorganic, are disposed, so that the order pervading the system may be far more clearly perceived.

So of motion—In one most important branch, dynamics is still in its infancy; we know little or nothing of the minute motions by which the particles of matter are arranged, when bodies act chemically on each other. Even respecting the motions of fluids so much studied as electricity, and heat (if it be a fluid), and the operation of the magnetic influence, science is so imperfect, and our data from observation so scanty, that mathematical reasoning has as yet hardly ever been applied to the subject. It is the hope of men who reflect on these things, and it is probably the expectation of those who most deeply meditate upon them, that, in future times, a retrospect upon the fabric of our present knowledge, shall be the source of wonder and compassion—wonder at the advances made from such small beginnings—compassion for the narrow sphere within which our knowledge is confined:—and when the greater part of what we are now only able to believe regular and systematic from analogy and conjecture, will have fallen into an order and an arrangement certainly known and distinctly perceived.

THE END.

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[illegible]